LIST OF ILLUSTRATIONS

COMMERCIAL PAINTS AND PAINTING

A HANDBOOK FOR ARCHITECTS, ENGINEERS, PROPERTY OWNERS, PAINTERS AND DECORATORS, ETC

BY

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PREFACE

ALTHOUGH there are many books on Commercial Paints and Painting, they deal almost without exception either with the manufacture of painters' materials, such as white lead, colour, enamels, varnish, etc., or are intended for the painter and decorator, and explain at length the methods of the actual application of the paint.

The architect, engineer, or property owner, for whom this book is chiefly intended, does not as a rule wish to know much about the actual process of manufacture, this being a matter for the paint colour and varnish maker; neither is he greatly interested in the actual application of the paint, which may be regarded as the decorator's concern. What he does wish to know is how a thoroughly durable job of painting in its many and varied applications may be done at a minimum cost consistent with good material and good workmanship.

In this work an endeavour has been made to deal with the subject in such a manner as to render this information readily attainable, and it is hoped that the fact has been made clear that low priced paints are usually far from economical, while those which cost high prices are often really cheap, because of the length of time they last. An explanation of the application of paints, varnishes, etc., has been given at sufficient length to enable the engineer, etc., to specify accurately. All the principal materials which enter into commercial painting have been described in detail, and various surfaces such as

wood, iron, cement, etc., have been dealt with separately, and the best paints, or protective material, mentioned in detail.

The chapter on paint spraying and paint dipping is based on observations of visits to manufactories where the process is in use.

It is well known that specifications for painters' work are frequently very far from being complete. The extracts from specifications of various public bodies and the comments made will, it is hoped, be of assistance to the reader in drawing up specifications which will at once ensure good work and form a reliable guide to the contractor.

The author desires to thank the City, Borough, and other Engineers-in-Chief, who have so kindly sent to him specifications governing the supply of painters' materials.

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The "Westminster" Series

COMMERCIAL PAINTS AND PAINTING

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INTRODUCTION

PAINT has been defined as "a mixture of opaque or semi-opaque substances (pigments) with liquids, capable of application to surfaces by means of a brush or a painting machine, or by dipping and forming an adhesive coating thereon." To this may be added "which will dry hard."

The object of painting any surface, whether wood, iron, cement, concrete or other material, is usually two-fold. First to preserve it from decay or corrosion, and second to decorate it. A third object is usually effected, viz., that of improving the hygienic condition of the surface, and in some cases, such as in limewhiting cattle pens, this is the sole reason for the application of the wash.

In nearly every case of painting the preservative qualities of a paint are of paramount importance and far exceed every other characteristic. Even when the pleasing appearance of a paint is of great importance, such as in interior decoration, its preservative qualities and its durability are still of great moment, for it is of little use to beautifully decorate a building with a material which will soon fade or decay, and it is very expensive, as will presently be shown.

The appearance of a paint, then, being agreeable, its value will wholly depend upon the length of time it will continue to preserve the surface to which it is applied. In other words, assuming that it is a good preservative when it is first put on, its value will be determined by how long it will continue to perform that function. Paint that has decayed considerably no longer protects the surface to which it is applied, and in certain cases, such as when badly cracked,

it may actually do more harm than good by holding in the cracks rain-water, which will penetrate the surface beneath and cause it to perish sooner than would otherwise have been the case.

Throughout this book, then, the question of the durability of paint, or how long it will last, has been taken to be the all-important part of the subject which almost entirely overrides every other consideration. The first cost of the paint itself is of minor importance, if it only lasts in a good condition for a long time. The explanation can readily be found in a consideration of the cost of labour in its application. It may safely be taken as a general rule that, in all ordinary work of house-painting, the ratio of cost between materials and labour is as one is to two. In other words, the labour costs just twice as much as the material. In simple work, done from the ground, such as plain fence or wall work, the cost of labour would be proportionally less, and in some work requiring the erection of elaborate scaffolding, or involving exceptional difficulties, such as the painting of a railway station roof, or a large iron bridge, the item for labour might be much higher than two-thirds. Obviously no exact proportion can be given, so much will depend upon the quality of the material employed, this quality determining the price. By way of an example, we shall take the price of labour and material as being exactly equal, although the labour would in most cases cost considerably more than the paint.

Let it be supposed that a house owner decides to use a cheap paint which will last only three years, and that one ton, costing £10 is required for the work. Taking the cost of application as £10 — although it would be in most cases much more — we have a total cost each time the work is painted of £20. At the end of every three years the work is done again at the same cost and with similar paint, so that at the end of thirty years the sum of £200 has been expended on paints and painting. Now let us suppose that instead of using the cheapest paint, the property owner pays as much as £30 per ton for a paint which would last ten years. In that case he would spend £30 for material on three occasions during the thirty years, and £10 on each occasion for labour—for the cost of applying the best paint is usually not more than that of the cheapest, and sometimes it is less—making the total expenditure for the thirty years

only £120, as against £200 when the cheap paint was used. From a consideration of these figures it will be clear that if twice as much was paid for one paint as another, which will only last half as long, a considerable economy is effected because of the saving in the cost of labour.

It seems hardly necessary to put these facts more forcibly, yet they are so frequently overlooked, or are disregarded, that one more example may be given. One gallon of a first-class pure white lead paint when mixed ready for use costs about 10*s*. 6*d*. to 12*s*. 6*d*. For our present purpose we will take it at the latter figure. Such a paint will last in a fair condition for from three to five years when exposed outside in a town to the wear of the elements. We will suppose that ten gallons of such paint are required for the finish of an ordinary building, and that this is renewed every four years for a period of forty years, or ten times during that period. The cost of paint at each application will be £6 5*s*., making a total of £62 10*s*. for the paint alone during the forty years. Taking the cost of labour at the very low rate of that of the cost of material—and as explained this is considerably lower than it could possibly be done for under ordinary circumstances—we have a total cost of £125 for keeping this particular building adequately protected by paint during the forty years.

We will now consider the total cost during the same period of using a paint which is much higher in price but which lasts very much longer. We will suppose that the paint in this case costs 30*s*. a gallon, a price which is higher than any ordinary paint on the market, a first-class enamel only costing 20*s*. We will also imagine that the 30*s*. paint lasts ten years. The cost of paint for the forty years will be 30*s*. × 10 = £15. This multiplied by 4, the number of times the building is painted during the forty years, gives a total of £60 for the material. But the cost of labour in applying the high grade paint will be exactly the same as that of applying the cheaper material, and as the building is only repainted four times during the forty years the labour will amount only to £6 5*s*. each time, making the total for labour £25, which, added to the cost of the material, £60, gives a grand total of £85 for the forty years, as against £125, the cost of using the cheaper paint.

Of course these figures might be given in varied form almost indefinitely. One more, based on the usual allowance of one-third for materials and two-thirds cost of labour, may be included to strike the argument home, and here we will take the case of paint at 7*s.* 6*d.* a gallon which lasts five years, compared with a paint at 20*s.* a gallon which lasts ten years, the period covered being one hundred years, or one year over the term of the usual ninety-nine years' lease. We shall again assume that ten gallons are required for the job.

Ordinary paint at 7*s.* 6*d.* a gallon :—Cost of paint each time, 75*s.* × 20, the number of times repainted in one hundred years, equals £75 for material ; labour or cost of applying the paint at 15*s.* per gallon × 10 = £7 10*s.* ; number of gallons = £7 10*s.* × 20, number of times repainted = £150, or a grand total of £225 for keeping the property properly painted for one hundred years.

Special paint at 20*s.* a gallon :—Cost of paint each time painted, £10 × 10, number of times repainted in one hundred years = £100 for material ; labour same as before, £7 10*s.* each time, multiplied by 10 = £75, or a total of £175 against £225.

Of course, when cheaper paint, which costs much less per gallon and lasts only one or two years, is taken, the difference is even more striking.

It may be remarked here that the system of granting leases in vogue for many years past, at least in the neighbourhood of London, in which the lessee is required to repaint outside work every three years (in some places five) and every seven years inside, is directly responsible for more bad paint than anything else. A lessee, knowing that he must by the covenants of his lease paint so frequently, naturally does not care to pay for the best paint.

A really first-class paint designed for the special purpose for which it is required, *i.e.*, the surface to which it is to be applied, and the situation it is to occupy, should last at the very least six years on outside work, and twenty to thirty on inside work. The writer has known cases of grained work lasting fifty years and being at the end of that time in excellent condition, excepting in places where it has been injured by knocking. High-class enamels when properly applied should last from seven to ten years when exposed to the weather and almost indefinitely when used inside.

From what has been said it will be seen that it is of paramount importance to the property owner, architect and engineer to consider not only the first cost of paint and painting, but how often the paint must be renewed. If it should be thought that the above points have been somewhat laboured, the answer is that notwithstanding that the facts are so obvious, the demand for cheap paints which last but a little while still continues unabated.

The cost of keeping property painted has been likened to that of insurance - a tax, it is true, but a very necessary one. Some short-sighted owners of house property very foolishly neglect to repaint as often as is necessary, and not infrequently delay the work until the greater part of the paint film has disappeared, the result being that a permanent condition of decay is started, which often cannot be arrested, as, for instance, in the case of iron, which, if once rusted, will continue to oxidise even after a coat of paint has been applied, unless every particle of rust is first removed. Wood which has commenced to decay will also continue to do so even when a coat of paint is given to it, for it must be remembered that the paint film is by no means impervious to air and water, however great are the efforts which are made to render it so. It should be very clearly understood that there can be no one paint which is suitable for any and all materials or all situations. A paint which would be very suitable for outside woodwork in the pure air of the country might be wholly unsuitable for a house situated on the seashore, or in a smoky town such as London, Sheffield, Widnes or Runcorn. Again, different surfaces require entirely different paints, a variation being made not only in the pigment but also in the thinners (oil and turpentine). Thus in painting on iron much less thinners are required than is necessary on an absorbent surface such as cement. Again, the constituent parts of a paint must be varied exactly in accordance with the condition of the surface, and the painter, knowing this, uses more or less thinners when painting on different kinds of plaster, or on different kinds of wood. In the preparation of special or proprietary paints these facts are carefully borne in mind, and they are often supplied in a condition which requires the addition of more or less thinners according to circumstances. The variation in the pigments or an admixture of different pigments is

not so usual, although it is every day becoming more generally recognised that a paint should be designed for the special service it has to perform, and that several pigments mixed together in the proper proportion are almost universally the most successful.

It is suggested that architects, engineers and others who are called upon to specify paint might with advantage get into closer touch with paint manufacturers so as to consult them when any special paint or varnish is required. Consultation of this kind is of course quite usual in many branches of the building trade. As a rule, if an architect requires any special work done in, say, electric light, an artesian well or a series of lifts, he consults an expert on the subject, and explains what is wanted, leaving the details to be worked out by the man who has made a special study of the subject. Exactly the same action should be taken in the case of paint, so that the architect, instead of always specifying "four coats of lead and oil," as is customary, or the engineer red lead or oxide of iron for his ironwork, should take advantage of the paint makers' expert knowledge both for his protection and that of his client. Many of the leading firms of paint and varnish manufacturers now employ specially trained men to give advice under such circumstances, and some architects do not fail to take advantage of it.

CHAPTER I

The Materials used in Commercial Painting.

Paint usually consists of four parts—pigment, oil, volatile spirit and driers. Varnish is sometimes added. If the paint is white the pigment is composed of white lead (hydro-carbonate of lead), sublimed lead (basic sulphate of lead), oxide of zinc, lithopone or an admixture of them with or without other pigments, such as barytes (sulphate of barium), silica, alumina, china clay, gypsum, Paris white, etc. If the paint is coloured it may be formed of a chemical colour or natural earth colour added to the white base, as, for instance, Prussian blue or umber added to white lead. Or the pigment colour, either chemical or natural, may be used by itself without a white base, such as in the case of siennas, ochres, greens and red lead. Sometimes the pigment is replaced by a metal, as in aluminium paint, for example.

White lead, zinc oxide and other similar pigments are for the most part supplied to the painter ground into a stiff paste in linseed oil, and it is his business to thin them to the necessary consistency by adding more linseed oil and turpentine according to how far the surface to which they are to be applied is absorbent. Driers or materials having a great affinity to oxygen are added to hasten the "drying" or hardening of the paint film. Some pigments, such as red lead, require no driers; others a very little, and still others a larger quantity. Linseed oil is almost invariably used as a paint oil, but other oils, such as tung or Chinese wood oil, menhaden fish oil, soya bean, poppy-seed, and walnut oil may be used under certain circumstances. American turpentine is most used for thinning the paint, but this may be replaced by white spirit of petroleum origin, if it be specially prepared for the purpose. The characteristics of all the constituents of a paint and their uses are explained at length

under their various heads, and the process of applying the paint is also explained.

From the painter's and decorator's point of view, pigments may be defined as those materials which form paint when ground with a drying oil, such as linseed. All pigments may conveniently be divided into four classes, namely :—

(*a*) Those of natural origin, usually termed earth colours, *e.g.*, ochre, sienna, umber.

(*b*) Pigments made on a chemical basis, *e.g.*, chrome yellow, white lead, etc.

(*c*) Pigments produced by the agency of heat, *e.g.*, zinc oxide, sublimed white lead, etc.

(*d*) Pigments derived from coal tar, vegetable or animal matter, *e.g.*, madder, crimson lake, fast red, etc.

Natural or Earth Colours.

Among all the colours in command of the painter, none stand higher in all round excellence than the earth or native colours. They are found in various parts of the world, are cheap and by far the most durable of any colours known. Dr. A. P. Laurie, Professor of Chemistry to the Royal Academy of Arts and Principal of the Heriot-Watt College at Edinburgh, some time since made a very careful investigation of the colours used by the old masters, in order to ascertain their chemical nature, and thereby to determine their extreme durability. He found that in most cases they were earth or natural colours, even the greens being terra verte or its equivalent. Many of the earth colours consist of silicate of alumina or common clay coloured with ferric oxide. The colour, tone and fineness to a large extent determine the value of the pigment.

It is not deemed advisable to enter here into the question of the manufacture and treatment of the earth colours, in order to render them fit for the use of the painter, but it may be said that generally speaking they are treated by the process known as levigation, so as to separate all coarse particles and leave only the fine pigment remaining. This is done by passing the colour through a series of tanks containing water; the colour is agitated in the water and

afterwards allowed to settle, the top portion containing the finer and therefore lighter parts of the colour floating off into the next tank, and so on to the end. The colour is then dried and ground in oil, turpentine or water, as the case may require. Many of the earth colours are calcined, which deepens their colour, as, for example, in the case of siennas, umbers, etc., when we have raw sienna, and burnt sienna, raw umber and burnt umber, etc.

The following is a description of the different earth pigments and colours in common use, and it will be observed that in some cases the use of the natural colours is very limited, those artificially made having taken their place because of their cheapness.

Barytes.—This pigment is chemically known as sulphate of barium, and the natural variety is obtained from "heavy spar" found in Derbyshire and many other parts of the world. When mined, it is a very heavy rock. This is crushed to the form of powder, and sometimes has a yellowish cast which is corrected by the addition of a little blue. It is largely used in the reduction of white lead, and in the cheaper colours. It is quite inert, but possesses little or no body, and the author has tried the experiment of having barytes ground in oil and applying as many as six coats without hiding the knots and grain of the woodwork. Moreover, it is not durable when used alone, but when added in a proportion up to, say, 5 to 8 per cent., it is an advantage rather than otherwise, because it is unaffected by sulphuretted hydrogen and other conditions. It is insoluble in water and dilute acids.

It will thus be seen that although it is looked upon as an adulterant it really is not such, provided its presence is known. If more than 10 per cent. is added to white lead it would interfere with the body of the paint. Meyer says: "The addition of barytes to artificial mineral colours or to lake pigments is by no means to be classed as an adulterant, as the result is that colours are sold at a correspondingly low price to the advantage of the buyer (!). And again, most colours especially the lakes, would be of no particular use without this addition." Dr. Toch says: "The value of barytes as a white pigment is being recognized more and more each year, and although very little, if any, is used alone for this purpose, it is used in large quantities in

combination with white lead, zinc white, or a combination of both of these white pigments. This addition is not considered an adulteration, as was the case a few years ago, for it is now appreciated that the addition of barytes makes a white pigment more permanent, less likely to be attacked by acids, and freer from discoloration than when white lead is used alone. It is also believed that barytes gives greater body to paint and makes it more resistant to the influences of the weather. As is well known, pure white lead when remaining in the shade or in a dark place becomes discoloured, turning yellowish, while mixtures of white lead and zinc white, or white lead and barytes, or white lead, zinc white, and barytes, retain their colour permanently even in dark places."

The amount of barytes that can be mixed with coloured pigments without injuring them is remarkably large There are hundreds of brands of para-red paints made and consumed every year by the agricultural implement trade which contain as high as 90 per cent. of natural barytes. When it is taken into consideration that these extremely diluted para-reds cover well and serve their purpose most admirably, the expert should be very careful not to condemn barytes when used in large quantities, for this remarkable behaviour is repeated with a large number of other pigments.

No paint chemist will dispute the fact that barytes adds wearing quality to paint, but inasmuch as white lead has set the standard for ease of working, it is admitted that all the other pigments and fillers are not as unctuous as white lead. Therefore the house painter will notice that the so-called lead combination, which contains large quantities of barytes, does not work as freely under the brush as white lead; nevertheless, this objection does not hold good when the barytes is used in moderate quantities, that is, not to exceed one-third of the total pigment of a paint. An experiment was made with a mixture of one-third carbonate of lead, one-third zinc oxide, and one-third barytes on an exposed wall of a high building in New York City, in 1884. This surface is still in a moderately good state of preservation, and as a comparison a wall painted five years ago with the pure Dutch process white lead shows that the Dutch process white lead has not stood as well in five years as the combination mixture has stood for twenty years. It is

conceded that no paint is supposed to last twenty years, but as a matter of record it is interesting to note that the inert filler added so much to the life of the paint which contained it. In view of this fact, the paint manufacturer is justified in recommending to his customers the use of inert fillers in his paint on the ground of increased longevity.

Indian Red.—Although Indian red is a natural colour, it is sold under various names, such as red oxide, iron red, and hæmatite. It is also very largely made from by-products, and also from dry copperas.

The natural Indian red consists of over 90 per cent. of ferric oxide, together with a little silicate of alumina. It is an exceedingly fine pigment, and has a high covering power or body. The finest variety is the well-known rouge which is employed for polishing silver and other metals.

Iron Oxides in Paint.—Prof. G. W. Thompson, in an address said :—" It must be generally admitted that all white paints decay more rapidly than coloured paints, especially those coloured paints which are characterised as warm in tone."

In view of this well-established fact, it is rather remarkable that popular taste, during recent years, has run strongly towards the less durable colours.

The oxides of iron, whether natural or artificial, when properly prepared, are all decidedly warm in tone and all produce highly durable paints. The range of tone and colour is very wide and the effect pleasing. They hold their colour remarkably well, are the most economical and have none of the defects common to very light tints, such as chalking, cracking, peeling, scaling, etc.

If instead of producing light tints by adding a small percentage of colour to a large quantity of white paint, the proportion of the iron oxide were increased, paint consumers would be immeasurably benefited.

The abundance and cheapness of ochres has always made them attractive for popular use, and the silica base ochres have long enjoyed popularity as a cheap priming coat. As tinting colours to impart a yellow tone to other pigments they are unsurpassed, generally increasing the durability of the paint.

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The hæmatite colours, both natural and artificial, are among the most highly satisfactory pigments known. Their colour is uniformly bright and pleasing, and the tints produced by them are warm and rich. Their colour is practically unalterable under any conditions. They are highly decorative, durably protective and gratifyingly economical.

Of their general excellence Hurst says: "As a pigment, red oxides are perfectly permanent under all conditions and are among the most permanent colours a painter can use. They mix perfectly with all pigments without either affecting them in any way, or being affected by them."

F. Maire says: "Venetian reds made upon a gypsum base are reliable and practically unchangeable by exposure to light and air. Venetian red, either the natural or the artificial, may be mixed with other pigments with perfect safety. . . . It is one of the few colours that cannot be spared and could be replaced by no other red pigment."

Concerning Indian red he says: "It is most permanent; neither light nor impure air, mixing it with other pigments, time, nor fire, seem to cause change in any way."

Parry and Coste say of the iron oxide pigments: "A most important class of colours, on account of their extensive use . . . and of their high intrinsic value."

Terry says: "The pigments composed of ferric oxide are used in enormous quantity. They are distinguished by great permanence."

Toch says: "Among the red pigments in the paint industry, the oxides of iron take the lead as by far the most useful." He states that on an iron roof "a mixture of graphite and ferric oxide . . . outlasted graphite by two years and red lead by three years."

Sabin says: "No colours are more permanent than some of these pure oxides. They have lasted for thousands of years and there is no reason why they should ever change."

Zerr and Rubencamp say: "A coating of red oxide paint is a perfect protection against rust, a property upon which is based the xtensive use of this pigment for painting ironwork."

Ochre.—This useful pigment varies in colour according to the amount of hydroxide of iron present. It is very permanent and is

unaffected when mixed with any other colour, excepting some of the lakes. It is suitable for grinding in any vehicle with oil, turpentine or water. The best qualities contain about 60 per cent. of ferric oxide and 40 per cent. of silicate of alumina. The colour varies greatly according to the place from which the ochre comes. Some varieties are pale yellow, others a much brighter yellow, varying to a distinct brick red, when the name red ochre is usually given. This pigment is sold under various names such as golden ochre, Oxford ochre, etc. The former is sometimes mixed with a little chrome yellow to improve its brilliancy. Oxford ochre, although still sold under that name, has ceased to exist, as the fine colour obtained from the vicinity of Oxford has long ago become exhausted.

Sienna.—This colour may be regarded almost as a bright ochre, as it is similar in general properties. When calcined, it becomes a rich brown and is very valuable for the purpose of decoration. Sienna is usually very finely ground and is used by grainers to a considerable extent together with umber and other earth colours.

Terra Verte.—This is a natural green, of subdued colour, having a bluish grey cast. It is best used over red, which intensifies the green colour. It is permanent, hence the green on the paintings of the old masters before referred to is found to last almost indefinitely. It is not affected by sulphurous fumes, and it is inadvisable to use it in connection with lakes.

Umber. In many respects umber is similar to ochre and sienna, but it is much darker and yields a very pleasing colour when burnt, becoming darker and richer.

Umber works well in oil, water, and turpentine. It is quite permanent and nearly acid proof. Alkali has no effect upon it. Zerr and Rubencamp say: "All brands of umber serve as very durable varnish paints which dry very quickly and hard. Umber is an essential ingredient of weather proof paints for outdoor use, and gives a specially rich assortment for painting house fronts."

Vandyke Brown.—Originally, Vandyke Brown was a native mineral, hence it is classified under that head; but in recent years the bulk of the Vandyke brown sold is made from burning cork cuttings and organic materials, or by mixing lamp and vegetable blacks with

red oxide and a little yellow ochre. Vandyke brown is a bad dryer, but is permanent, and mixes well with other pigments. A variety of the original or natural Vandyke brown is sold under the name of Cassell brown.

Venetian Red.- This colour may be regarded as a mixture of a considerable quantity of sulphate of calcium, ferric oxide, and silicate of alumina, with occasionally a little manganese. Notwithstanding the presence of the calcium carbonate a convenient example of which is ordinary chalk, Venetian red is as a matter of fact very durable, and is used to a considerable extent for painting railway cars, a position which is obviously very trying. The colour is a brick red, and some pleasing tints can be obtained, although it is inadvisable to mix much white with the colour owing to the large amount of chalk contained. It is, however, supplied in various shades, and can then be used as it is received from the manufacturer.

Special Browns.—During recent years, the efforts of colour manufacturers have been successfully directed to the production of special mixtures of colours of the same class with a view of producing pleasing and permanent tints, which may be regarded as a distinct improvement on any one pigment used by itself. Thus many beautiful shades of green are made, which may be employed exactly as received, and without adding white or any other pigment, and these vary from bright emerald-like colours, to subdued and sombre tints. A similar admixture has been adopted in the case of browns, and by a judicious intermingling of the brown and yellow earth colours, such as umber, burnt or raw siennas and ochres, with or without other pigments, white or coloured, some very excellently toned colours are produced.

Chemical Colours, etc.

Blanc Fixe.—This pigment is chemically the same as natural barytes, with the chemical formula of $BaSO_4$; but it is very different in physical properties, being much finer in texture and possessing much greater body. It is also called permanent white, and fast white. It is used by artists and is an important constituent of the lithopones (*q.v.*).

Brunswick Blue.—This colour is really a cheap variety of Prussian blue, in which the blue is combined with a considerable amount ot mineral white, such as barytes. The presence of this white is accounted for by the fact that pure Prussian blue is too intense in colour to be of advantage, while it is difficult to grind into paint. It is also too costly for general use.

Chrome Green.—This trade term is frequently applied to two pigments which are quite different in their composition. The first is a green prepared in the manner of Brunswick green, but from pure chromate of lead, and pure Prussian blue without any barytes or other similar material. This colour, however, is only used by artists. It is much more costly than ordinary Brunswick green, but has greater staining power. Sometimes the name is applied to the oxide of the metal chromium prepared as a pigment, which is a rather dull but exceedingly durable green. This is also high in cost and is only used for the best work.

Cobalt.—This is the most durable and valuable blue pigment known, but is not used much in house-painting on account of its great cost. In composition it is a combination of the oxides of the metals cobalt and aluminium. It is perfectly permanent to light and air and resists both acids and alkalies. It is also entirely without action on other pigments with which it may be mixed.

Lead Chromes.—These vary in composition according to the tint, the grades usually sold being yellow chrome, middle chrome and orange chrome. The first is chromate of lead combined with sulphate of lead or white lead, the second is pure chromate of lead, and the third is basic chromate of lead. Included in the same class is chrome red, which is practically the same compound as orange chrome, but in a different condition. It is also known as "Derby red," and "American vermilion," and is valuable for the protection of iron.

The chromes generally cannot be regarded as very durable pigments as impure atmosphere is liable to discolour them owing to the action of sulphuretted hydrogen. They also tend to fade on exposure. They are used in the preparation of Brunswick greens, to which is added from 60 to 80 per cent. barytes, which cannot be regarded as an adulterant, but is a proper constituent of such greens.

Lithopone.—This valuable pigment consists of sulphide of zinc and sulphate of barium precipitated together in the proportion of about one-third of the former and two-thirds of the latter. Sometimes a little oxide of zinc is present. The sulphate of barium is dense and practically equivalent to blanc fixe (*q.v.*)

Notwithstanding the immense increase in the sale of lithopone in recent years, there are two features which seriously hamper its wide popularity. The first of these is that most grades—there are exceptions—are not suitable for outside work, owing to the fact that lithopone changes colour under certain conditions, and also that it has been demonstrated that unless it is protected by a coat of varnish or a paint of a different quality it will not last for any considerable length of time. Those, therefore, who have used it outside, and have not had satisfactory results, are too apt to condemn it wholly, and to imagine that it is equally useless inside. This, however, is not the case, and the writer believes that for all ordinary purposes it may be employed on the interior of buildings, and if properly mixed with pure oil and turpentine, and applied in a skilful manner, it will be equal in all respects to white lead, although it will be found to be considerably cheaper.

And this brings us to the second point urged against it. It is the fact of it being comparatively cheap. One can understand that cheapness frequently means inferiority; if, for example, a tailor offered to make a suit of clothes for two guineas, it would only be reasonable to suppose that in material, cut and make it would not be up to the mark. But with paint materials the question is an entirely different one. There are certain properties which must be fulfilled in a paint which have already been explained at length, and if those properties are possessed by a paint, the question of cost will largely depend upon the expense of the production of the raw material. It is in this respect that lithopone is found to be economical in use, and it should not be condemned merely because it costs less than a pigment like white lead.

Prussian Blue.—This is a complex compound of iron and an organic substance allied to Prussic acid, but it is nevertheless non-poisonous. The ordinary manner of manufacture as carried on to-day is as follows:—A substance known as yellow prussiate of

potash, forming large bright yellow crystals something like barley sugar, is obtained as a by-product in the manufacture of coal tar. This is dissolved in water, and a solution of copperas (sulphate of iron) is added, together with an oxidising agent, when the blue is produced. It is then collected by filtering, is washed and dried. The purest forms are known as milori and Chinese blue. In the manufacture of these materials they are greatly purified, and the blues come into the market in lumps having an intense colour with a bronze appearance on the surface. Sometimes this peculiar bronze effect is regarded as an indication of poor quality, while as a fact it is exactly the reverse. Cheap qualities of Prussian blue are produced from less pure materials, such as gas blue, and are not so fine in texture or so pure in colour; for example Chinese blue when ground in oil is perfectly transparent and pure in colour, whereas gas blue shows muddy and gritty.

The colour is rather greenish in cast, and the pigment may be regarded as a stainer having no opacity. It is largely used to mix with chrome to form greens. It will stand acids, but is readily destroyed by alkalies, such as soda, potash, or lime, which change the colour to a rusty brown. Prussian blue must not, therefore, be used in distemper or on new plaster or cement. It is fairly durable on exposure to light, but in the course of time fades to a grey.

Ultramarine.—This useful blue was introduced in the early part of the nineteenth century, as the result of chemical research. It is an artificial preparation of natural ultramarine obtained from the mineral lapis lazuli. It is exceedingly complex in composition, being a compound of silica, alumina, soda, and sulphur. Ultramarine is produced in a large range of qualities varying not only in fineness but colouring power and also in composition. It is perfectly fast to light and is not destroyed by alkalies. The varieties rich in silica are more particularly valuable in this respect. Acids, however, even if weak, spoil the colour. The colour is frequently used in minute quantities to correct the tone of white pigments, and for this purpose the very finest quality must be employed, absolutely free from free sulphur. Modern lime blues, used for colouring lime wash and distemper, are the coarser varieties of ultramarine.

White Lead.—Although it has not been thought advisable to include in this book anything more than a very brief reference to the manufacture of painters' materials, an exception may be made in the case of white lead for the reason that the process of manufacture to a great extent determines the quality of the resultant product. The white lead which is most esteemed is that made by what is known as the Old Dutch or Stack process, and this has been in use for hundreds of years past. It is a curious fact that although the process is somewhat crude and primitive the very many attempts which have been made to improve it have not, on the whole, produced a superior product.

In the stack process the metal lead is first freed from impurities, particularly silver, which are usually found in lead, and would have an objectionable effect if allowed to remain. The pig lead is melted in large open vessels; metallic zinc is then added, and as the mixture cools the silver unites with the zinc, to which it has a greater affinity than for lead, and the two metals together form a scum on the top of the molten mass. This is raked off from time to time, and the process is then repeated until all the silver is extracted. The pure lead is then cast into the form of what are known as "wickets," which may be described as having somewhat the appearance of a miniature five-barred gate. The actual shape of the wickets vary largely in different factories. The floor of the stack in which the corrosion of the lead takes place is covered with spent tan or manure, and upon this are placed earthenware pots quite close together. These are half filled with dilute acetic acid. Usually the wickets are strewn upon these pots, but sometimes the wickets are placed in the pot itself, lugs or projections being provided to prevent them actually touching the acid. When one layer is completed in the manner described, suitable beams and planks are placed over the pots, but only touching those that act as supports at the end; thus a new floor is formed. Upon this more spent tan is placed, another series of pots with the wickets on top and so on until the top of the stack is reached, when it is sealed so as to exclude air and confine the fumes of moisture, acetic and carbonic acids given off by the generation of heat of the tan bark. At the end of about three months the greater part of the metal lead will be found to have

been converted into white lead. The corroded wickets are then passed through corrugated rollers to separate the metal and the product is afterwards washed and dried.

The dry white lead is sold to paint manufacturers, who grind it in oil ready for use by the painter, who thins it with linseed oil and turpentine in the manner already described. The corroders also grind the lead themselves, and send it out in the form of stiff paint. In the United States, a good deal of tinted lead is sold, *i.e.*, colours of a permanent character added to the lead in various proportions, sent out stiff, suitable for thinning. The use of this is found very economical in practice.

The advantages of lead over other pigments is, first, its body, although this is exceeded by a few pigments such as lithopone, fast reds, aluminium, etc. But the principal point in its favour is its smoothness of working. It being practically a lead soap, it possesses a certain greasy feeling when a brush is used. It is doubtless because this particular property is absent from some of the other pigments that journeymen painters are so likely to condemn them.

Zinc Yellow is a similar pigment to lead chrome, except that the lead is replaced by zinc. It does not darken in impure air, but is destroyed by alkalies and dissolved by acids.

PIGMENTS PRODUCED BY THE AGENCY OF HEAT.

Antimony Oxide.—This paint, although but little known among house painters, is largely employed for situations which are subject to sulphur and other fumes, and is therefore largely used for painting gasometers, and for work in the neighbourhood of gasworks. It is usually supplied in ready mixed form, but is sometimes supplied stiff, ground in refined linseed oil. The cost is about the same as white lead paint, but the spreading capacity is considerably greater, so that it is cheaper in use. If it is required to be thinned, boiled linseed oil and turpentine in the proportion of four to one should be used. The spreading capacity is about that of zinc oxide, it is therefore one-third more than white lead. Its body is nearly equal to that of white lead. When supplied ready mixed it contains the necessary driers, and nothing therefore should be added to it. It

is extensively employed on the seashore for piers, pavilions, lamp columns, etc., and withstands the weather better than white lead, and it is said, zinc oxide.

When once hard, sulphurous gases and ammoniacal fumes have no effect whatever upon it. Two of the largest railway companies in the United Kingdom use nothing but antimony paint on all the ironwork of their bridges, etc. The specific gravity is 5·25, and when ready mixed it weighs about 21 lbs. to the gallon. The following may be quoted from the book "Antimony," written by Mr. Chung Yu Wang, M.A., B.Sc. He says: "Antimony white paint can withstand the action of water, is as opaque as white lead, and is neither acted upon by sulphurous fumes nor by sulphuretted hydrogen. It is very durable for outside paint and is claimed to be non-poisonous. Furthermore, it possesses more opacity than zinc white, covers better, and is cheaper."

Dr. Charles Mayer, translator of Zerr and Rubencamp's treatise on Colour Manufacture, says: "Of late, antimony is largely used for colour manufacturing purposes. In France, and especially Italy, the manufacture of antimony white as a substitute for white lead has made a great advance, facilitated by prohibitive laws against white lead pigments."

Blacks.—The series of blacks used by painters are of considerable importance, particularly as they are extremely durable and consisting principally of carbon they are unaffected by alkali or acid. Blue black or Frankfort black is supposed to be made from shoots of the vine and other woods, but more frequently it is simply bone black or lamp black to which has been added a little blue. Drop black is the name given to a black which is made in the form of irregular cones, these being formed as they drop from the mill in which the black is ground. Ivory black is made by charring ivory waste, but very little of it is now made, the best grade of bone black being usually sold under this name. Lamp black is made from the fumes given off by burning various waste products such as oil.

Sublimed Lead.—This pigment is claimed to possess many advantages over ordinary corroded lead. It consists approximately of:—Lead sulphate ($PbO, PbSO_4$) = 75 per cent.; lead oxide (PbO)

= 20 per cent., and zinc oxide (ZnO) = 5 per cent. It is an amorphous pigment nearly as fine in texture as lamp black or zinc oxide and is made by crushing and refining gelena (lead ore) and then burning with carbon, in a specially constructed furnace. In the final stage the lead is changed to vapour, air being admitted for the sake of its oxygen. The fumes pass through condensing pipes and on cooling yield sublimed white lead, which is collected in bags. It mixes well with linseed oil and rather more than one gallon is required for 100 lbs. of dry white lead.

The following description of sublimed lead is given by the North Dakota Agricultural Experiment Station: "This product is so named because it is prepared by a sublimation process. The product is obtained directly as a very fine impalpable white powder without grinding. Chemically it is very different from ordinary white lead, being apparently a basic sulphate of lead. The specific gravity is 6·2, approximately that of ordinary white lead, and it is at least equal to it in whiteness, body, covering power and wearing qualities. It differs from the ordinary white lead in being non-poisonous[1] and it resists the blackening action of the sulphur compounds of sewer gas to a much greater degree. It is well suited for mixing with zinc oxide. It never hardens in the can and remains soft for a much longer time than carbonate of lead, which has a tendency to harden in the package."

Zinc Grey.—As mentioned elsewhere, this pigment when ground in oil or varnish (particularly the latter) is largely used on the Continent for the protection of iron and other metal surfaces. It is also very useful for painting machinery. It may be regarded as a by-product in the manufacture of zinc oxide. When the spelter is burned it passes away as vapour through a pipe or channel, and this vapour, on cooling, forms the oxide of zinc of commerce. This is received in bags, and it is found that those bags which are farthest away from the furnace contain, as one would reasonably expect, the finest grade of zinc oxide. Indeed, the fineness varies proportionally with the distance of the bag from the furnace. That nearest to it receives a deposit which contains a large proportion of metallic zinc,

[1] This quality is now generally disputed.

sometimes as much as 90 per cent., and this forms the zinc grey so highly esteemed by our neighbours across the Channel. It is heavy, covers well, and when mixed with varnish, forms an excellent protector of iron. Various mixtures of zinc oxide and black, with or without the addition of other black and white pigments, are sometimes sold as "zinc grey," although, strictly speaking, they have no claim to the title.

Zinc Oxide.—This is a very important pigment, which has made great progress in popularity in recent years. It is extensively used for the best enamels and varnish paints, and may either be used by itself or in admixture with other pigments, such as white lead. The specific gravity is 5·6, and it is very bulky in character, requiring about 20 per cent. of oil to form a paste. The best qualities are pure white in colour. The spreading power is much better than white lead, say one-third more, bulk for bulk. When zinc oxide is mixed into a paint in the ordinary manner it will be found to possess less opacity or body than white lead, but this applies only to the first coat, and to a certain extent also the second; but when a third or fourth coat is given the result in the opacity of all the coats is fully equal to lead. Zinc oxide is not visibly affected by sulphurous fumes, and it possesses a great advantage, it being non-poisonous, which accounts doubtless to a considerable extent for its having come into favour. It is manufactured by burning metallic zinc in air, when the oxide is formed in the form of white powder, which is collected by an arrangement of settling chambers or bags. The best quality, which is collected in the chambers furthest from the furnace, is pure oxide in a fine state of division, but those nearest to the first chamber contain a considerable quantity of metallic zinc (see zinc grey). By another process the oxide is obtained from the ore by a process of sublimation. This method cannot be applied to all ores. The plant is similar in character, but different in detail to that used when metallic zinc is burned. The product from lead ore is less pure, as it invariably contains a small percentage of sublimed lead, but it is cheaper, as the gas for preparing metal from the ore is saved. The presence of sublimed lead is no great detriment, as it rarely exceeds 5 per cent.

Lakes.—Lakes are made from artificial dyes and are very numerous. The most important to the decorator are the reds, the majority of which are prepared by precipitating various coal tar dyes on a base of red lead or orange lead. Some of the aniline dyes are inferior, as they quickly fade and being slightly soluble in oil cause "bleeding." Very durable and permanent reds are produced from the dye known as paranitraniline.

Carmines are made from cochineal, the colour matter being fixed by means of alum. The colour is not permanent, and has given place to the madder lakes. These, however, have but little body and are mostly used for glazing.

Characteristics of Different Paints.

Many readers may have been puzzled from time to time at colours changing their hue; this may be due to various causes, and without knowing the composition of the paint it is difficult to assign a reason for the change. White lead is a typical example of a paint which is affected by sulphur gases and impure air; hence, when lead is used as a paint in towns ordinarily called smoky, such as Sheffield or Widnes, it is likely to be affected for the same reason. It will be found to darken rapidly when used on buildings near to gasworks, in lavatories, or in stables. Zinc paints, which are not so affected, should invariably be used in such cases, or if the painter or property owner deems white lead a necessity, this may be used and a final coat of zinc oxide should be given to which has been added a little copal varnish.

Pigments affected by Impure Air.

The following is a list of the principal colours or pigments which are affected by sulphur, gases and impure air:—

Brunswick Green	Lemon Yellow
Chrome Orange	Naples Yellow
Cremnitz White	Silver White
Emerald Green	Verdigris
Flake White	White Lead.

Some colours are more or less fugitive, *i.e.*, under the influence of

light they quickly lose their predominant colour. This is found to be the case in wall papers, particularly those known as ingrains. These rapidly lose their prevailing colour, so that they are now rapidly going out of use. Certain greens are also far from being permanent, as, for instance, Brunswick green, which turns to blue after a few months' exposure.

Pigments affected by Light, etc.

The following is a list of pigments more or less fugitive, and which may be deemed to be affected by light. When protected by a coat of pale varnish, however, they may be regarded as fairly permanent :—

Bistre (water)
Brown Pink
Brunswick Green
Burnt Carmine
Carmine in water
Chrome Green
Citron Yellow
Crimson Lake
Dutch Pink
Gamboge
Indigo
Italian Pink
Lithopone
Magenta
Mauve Lake
Olive Green (oil)
Paris White
Pink Madder
Prussian Green (oil)
Rose Madder
Sepia (oil)
Verdigris
Violet Carmine
Yellow Carmine
Yellow Lake.

Some colours dry very much quicker than others, and in dealing with the slow-drying colours it is useless to add a large amount of driers, as it will seriously affect the durability of the paint, as is explained under the head of "Driers," p. 31.

The following is a list of

Colours which Dry slowly and irregularly :—

Alizarin Yellow
Alizarin Green
Alumina White or Lake White
Bone Brown
Brown Madder
Brown Pink
Carbon Black
Carmine Lake
Crimson Lake
Crimson Madder
Gamboge
Indian Yellow
Indigo
Italian Pink
Lamp Black
Magenta
Mauve

Orange Cadmium
Payne's Gray (oil)
Rose Doree
Sap Green (oil)
Scarlet Lake
Sepia (oil)
Vandyke Brown
Violet Carmine
Yellow Lake.

There are a few colours which cannot be mixed with others without their being affected; in other words, chemical reaction takes place, which more or less destroys both colours. For example, artificial ultramarine cannot be used with white lead, as the sulphur which it contains would act upon the lead carbonate and give a grayish instead of a blue tone. The same is true of vermilion, cadmium and all sulphides.

Below is a list of colours which are quite permanent when used alone, but are not permanent when mixed with some other colours:—

Antwerp Blue
Cobalt Blue
Emerald Green
Flake White
Hooker's Green
Madder Carmine
Extra Para Red
Madder Lake
Ochre
Paris Blue
Prussian Blue
Ultramarine (artificial)
Vermilion.

It now remains only to give a list of those colours which are absolutely permanent and which can be used separately or mixed with each other, without any one acting upon any other. These are unaffected by light, and may be regarded as

True Permanent Pigments.

Alizarin Crimson
Alizarin Orange
Alizarin Scarlet
Alizarin Carmine
Baryta White
Barytes
Black Lead
Blanc Fixe
Brilliant Ultramarine
Blue
Blue Black
Brown Ochre
Burnt Roman Ochre
Burnt Sienna
Burnt Umber
Caledonian Brown
Cappah Brown
Cerulean Blue
Charcoal Black
Charcoal Gray
China Clay
Chinese Vermilion
Chinese White
Chrome Oxide
Cobalt Green
Cobalt Violet
Constant White
Cork Black

Deep Madder
French Blue
French Ultramarine
French Veronese Green
Foundation White
Gold Ochre
Graphite
Indian Red
Ivory Black
Kaolin
Lamp Black
Leitch's Blue
Light Red
Mars Brown
Mars Orange
Mars Red
Mars Violet
Mars Yellow
Mineral Gray
Mineral White
Neutral Tint (oil)
Neutral Tint (water)
New Blue
Oxford Ochre
Oxide of Chromium
Oxide of Chromium (transparent)
Payne's Gray (water)
Permanent Blue
Permanent Violet
Permanent White
Permanent Yellow
Plumbago
Raw Sienna
Raw Umber
Roman Ochre
Roman Sepia
Satin White
Silver White
Strontian White
Sky Blue
Terra Alba
Terra Verte
Transparent Gold Ochre
Ultramarine (genuine)
Ultramarine Ash
Vandyke Brown
Venetian Red
Vermilion, Pale
Veronese Green
Viridian
Warm Sepia
Yellow Ochre
Zinc Green
Zinc Oxide
Zinc White.

Pigments Injurious to Health.

Finally we may give a list of poisonous pigments which is as follows:—

Chrome Green
Chrome Yellow
Emerald Green
Flake White
King's Yellow
Naples Yellow
Orange Mineral
Orpiment
Red Lead
Verdigris
White Lead.

Colours not suitable for Oil.

The following is a list of colours which may not be used in oil, *i.e.*, they must only be mixed with water:—

Bremen Blue
Blue Verditer
Dutch Pink
Gamboge
Lime Greens
Rose Pink
Zinc Chromes.

Colours not suitable for Water.

The following colours are not suitable for use in distemper :—

- Antwerp Blue
- Brown Lake
- Chrome Yellow (as made from lead)
- Naples Yellow
- Prussian Blue
- Prussian Brown
- Vermilionette
- White and Red Leads.

Specific Gravity of Principal Colours and Pigments.

Name of Pigment.	Chemical Symbol.	Specific Gravity.
Barytes	$BaSO_4$	4·40
Barytes, Precipitated	$BaSO_4$	4·14
Bone Black	—	2·31
Burnt Umber	—	3·33
Cadmium Yellow	CdS	4·35
Chinese Yellow	As_2S_3	4·77
Chromium Oxide	Cr_2O_3	3·12
Crimson Lake	—	1·89
Emerald Green (genuine)	-	2·71
English Vermilion	HgS	7·72
French Orange Mineral	- -	8·41
French Verdigris	- -	2·29
Golden Ochre	-	3·10
Indian Red	Fe_2O_3	4·73
Italian Burnt Sienna		3·47
Italian Raw Sienna	-	3·08
King's Yellow	AS_2S_3	6·33
Lead Sulphate	$PbSO_4$	6·08
Light Chrome Green	—	5·75
Light Chrome Yellow	—	6·41
Litharge (Buff colour)	PbO	8·66
Lithopone	$BaSO_4 + ZnS$	4·23
L.L. Chrome Yellow	—	5·91
Naples Yellow	- -	6·84
Orange Chrome Yellow	—	6·37
Oxford Ochre	—	2·82
Prussian Blue	—	1·95

Name of Pigment.	Chemical Symbol	Specific Gravity.
Purple Oxide	—	5·14
Red Lead	Pb_3O_4	8·68
Rose Madder	—	2·04
Sublimed Lead	PbO, $PbSO_4$	6·39
Turkey Raw Umber	—	3·49
Turkey Burnt Umber	—	3·51
Venetian Red, Dark	—	3·56
White Lead, "Dutch"	$2PbCO_3.Pb(O.H)$	6·75
White Lead, "Quick Process"	—	6·56
Zinc Oxide (Green seal)	ZnO	5·47
Zinc Oxide (selected)	ZnO	5·55

THE THINNERS USED IN PAINT.

Benzene, also called Benzol.—This is a light liquid produced by the distillation of coal-tar, and should not be confused with benzine, which is a petroleum product. Benzene may be used with advantage as a substitute for turpentine if mixed with certain other ingredients. When employed by itself, it possesses definite advantages only under certain circumstances. It is a splendid paint solvent, and is therefore used in paint removers. It has a peculiar property of penetrating wood to a greater extent than turpentine does. It may, therefore, be used with advantage in priming coats and in staining. It should, however, never be used for a finishing coat. When removing tar on painted work, benzene may be used as it will dissolve and permit of the greater part of the tar being taken away. It should not be used in a closed room, as the fumes might adversely affect the operators.

China Wood Oil.—This oil is obtained from the tung tree (*Aleurites cordita*) growing in China. It should not be confused with Japanese Wood Oil, which is obtained from a different tree and is somewhat different in its properties. The tung tree produces a fruit about the size of a small orange, but of the type of a chestnut, the three nuts contained in it being something like a brazil nut. The preparation in China is very primitive. The nuts are crushed and the oil extracted by hand pressers. In consequence the product varies a

good deal in quality and frequently is found to contain impurities in the shape of mucilage.

It is not suitable for use by the painter in place of linseed oil, as it dries quickly and forms a wrinkled or opaque skin, but it possesses valuable qualities on account of its resistance to moisture, which is a weak point in boiled oil. China Wood Oil is heavier than most other vegetable oils. The specific gravity is ·940. The smell is very peculiar and penetrating, it being something like that of rancid ham fat. The oil has the unique property of settling into a jelly when heated, to 500° F. On exposure to air the raw oil turns gradually solid. For use in paint manufacture it is first heated to 300° F., allowed to cool, and is then tanked to mature. The oil so treated is then combined with other oils which prevent it from gelatinising, and a thick oil is then produced. It somewhat resembles boiled linseed oil, but differs from it in forming a film which has a higher gloss and is more durable on exposure.

Linseed Oil.—This drying oil is practically the only one used in house-painting, although there are many other oils which dry and would be suitable for the purpose, but they are not to be obtained on a commercial basis. Linseed oil is obtained from the seed of the flax plant, and comes from various parts of the world. The best is known as Baltic, followed by Calcutta and La Plata. In the manufacture of the oil the seeds are cleaned and sifted free from impurities and seeds other than linseed. The linseeds are then crushed in a mill under edge runners, and are afterwards heated in a steam kettle. They are then placed in hydraulic presses to extract the oil, leaving behind a bulky mass, which is sold as feeding cake for cattle. The crude oil is stored, filtered, and otherwise refined, and forms the raw linseed oil of commerce. The process of refining consists of treating the oil in such a way as to remove various impurities such as mucilage, derived from the husks of the seeds, etc. which would tend to make the paint soft, bad drying, and lacking in durability. There are several special methods of refining. Refined linseed oil is a pale straw colour, has a characteristic smell and taste, and a specific gravity of ·935. When boiled with soda or potash it is completely saponified, yielding soap and glycerine. It is important to bear this point in mind when considering the

question of cleaning and alkali paint removers. When exposed to fresh air it "dries" or changes into an elastic solid.

Turpentine.—This most useful thinner is obtained by the distillation of the crude rosin, obtained from various species of pine. The best quality is the American. French turpentine is of a good character, but little goes to the English market. Russian turpentine possesses, as a rule, a very disagreeable odour, owing to the tar. The crude turpentine is made by making incisions in the pine trees and allowing the exuded sap to collect in boxes. This crude rosin is known as "gum thus," and is used in various industries. The turpentine of commerce is made by distilling with steam, the residue of the distillation being common rosin.

Pure American turpentine is water white, and possesses a characteristic smell. The specific gravity is from ·866 to ·869. It boils at 156° to 170° C., and the flash point is 95° F. When pure it is completely volatile. Tests for turpentine will be found under the head of "Testing Painters' Materials."

Until recent years, turpentine was the only substance used as a volatile thinner to increase the flow of paints and thin them when a sharp coat was required. Although it almost wholly evaporates, there is little doubt that to a certain extent it improves the drying of the paint, and this fact distinguishes it from substitutes. It is also largely used in the preparation of varnishes. Turpentine is sometimes adulterated with petroleum spirit, but this is not a serious detriment if the physical properties are not changed. A highly volatile spirit causes it to evaporate too quickly, beside increasing the risk of fire, whilst a heavy spirit makes it evaporate badly and consequently impairs the drying of the paint. Rosin spirit, rosin and rosin oil, are impurities sometimes found in turpentine, and they are highly objectionable.

Turpentine Substitutes.—The long-continued high price of American turpentine led a few years back to the introduction of turpentine substitutes, the best of which consists of petroleum or other spirit, similar to benzine, but of heavier fraction, so that it does not evaporate quicker than ordinary American turpentine. The author has made many experiments with "white spirits," the name that is usually applied to this class of material, and has found

that, for most ordinary purposes, it cent. of cobalt rosinate of
article. As will be seen on reference to This is of a strong pink
Mechanical Means," it is now very larg. It has, in fact, to be
purposes; but house painters are also c required. A liquid
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"flashing," *i.e.* showing in places a more or less glossy n a partly
Some of the substitutes sold are mixed with a prop. a spirit
genuine turpentine in order to give the characteristic smell
material, but there is no other advantage. hose
oil

Driers.

Certain substances, when added in small quantities to linseed and other oils, have a property of making them dry very much more quickly than they otherwise would. These substances are principally—(1) Compounds of lead, including litharge, red lead, lead acetate or sugar of lead, and lead borates: (2) Compounds of manganese, such as manganese dioxide, manganese sulphate, manganese borate; (3) Compounds of cobalt such as cobalt oxide and carbonate; and (4) Compounds of nickel such as oxide and sulphate. Until recent years, lead salts were the only ones used, but they had the disadvantage of causing the oil to darken and, in some cases affecting the pigments. Manganese compounds are very much more powerful, and pale drying oils can be prepared from them. Cobalt driers are still more powerful. When used in paint they have a tendency to brittleness, and unless used in very small quantities tend to cause white paint to become yellow. In all cases, only a small amount of the salt may be used. If added beyond a certain point, the drying may be actually retarded, and in any case the quality of the oil or paint is ruined. The maximum amount of the salt permissible is 5 per cent. of lead, 1 per cent. of manganese, and 0·5 per cent. of cobalt. A much more effective drier is produced by combining two or three salts of different metals than by using them separately; thus a combination of lead oxide and manganese oxide in the proportion of ten to one has a very

question of cleaning and alke'same quantity of either of the two fresh air it " dries " or cha·

Turpentine. - This mc forms in which driers are supplied to the tillation of the crude.st is called " paste driers," generally known The best quality is These are composed of a small amount of the character, but lithtioned above, mixed with a very large amount of possesses, as ostance. This is all ground to a paste in oil. The The crude t: underlying this preparation is first to obviate the and allowndency of the painter to add an excess of driers, and next is knowent, by the addition of the inert material, the drier hardening turpe it is used. It is very difficult for the non-technical man to resierstand that only a very small percentage of the metallic salt of any use, and if it was supplied to him pure he would be sure to add much more to the paint than would be required. Patent driers, however, frequently contain much more inert material than is required. The common composition of ordinary driers is whiting, 90 per cent., sugar of lead, 10 per cent., ground to a paste in linseed oil.

A better quality of patent driers will contain up to 50 per cent. of white lead or zinc oxide mixed with 40 per cent. of barytes or China clay, and 10 per cent. of a mixture of lead borate and manganese borate.

Liquid Driers.—The name " terebine " is often applied to all types of liquid driers, but it can only properly be applied to one made with a drier dissolved in oil rather than in spirit. Formerly terebine was made after the manner of varnish by melting a hard rosin and dissolving it in a large quantity of linseed oil, in which as much litharge had been dissolved as it would take up, the resulting varnish being thinned down by turpentine. Similar terebines are now made by taking advantage of the fact that organic lead salts can be prepared by either dissolving oxide of lead, manganese, cobalt, etc. in melted rosin to form rosinate of lead, etc., or by decomposing linseed oil with soda and then replacing the soda with lead, etc., to form linoleate of lead, etc. These salts can thus be readily dissolved in a mixture of oil and spirit, and form powerful driers. At the present time a good many liquid driers are nothing more than one of these metallic rosinates dissolved in petroleum

spirit. A solution containing 45 per cent. of cobalt rosinate of white spirit can be made in this way. This is of a strong pink colour and acts very energetically as a drier. It has, in fact, to be used with great caution, and but a little is required. A liquid drier made up with oil and spirit has the advantage of one made up with spirit only, inasmuch as it combines more readily with the oil contained in the paint, and is sure to produce a uniform composition. On the other hand, these driers tend to skin over when a partly filled can is left standing for any length of time, whereas a spirit drier will never skin.

It should be understood that driers added to paints cause those paints to harden by taking up oxygen from the air through the oil only; and although no precise rule can be given, it may be taken as a general guide that the more oil necessary to grind a pigment to a paste and to thin it with turpentine to a proper consistency suitable for application by a brush, the greater will be the quantity of driers required. Thus, white lead can be ground to a stiff paste in 7½ to 9 per cent. of linseed oil, and therefore requires but little driers, while lamp black, Prussian blue, and other pigments require seven to eight times the amount of oil.

VARNISHES, ETC.

Black Japan.—This material may be described as a black varnish, and is much more durable than Brunswick black, being made in an entirely different manner. When thinned with a considerable quantity of turpentine, it produces a variety of stains which are very useful, and colour may be added if desired.

Brunswick Black.—This is a useful black which is made of asphaltum, linseed oil, driers, and turps.

Knotting.—This material is often called "patent knotting." It is a shellac varnish, made by dissolving orange shellac in methylated spirits (64 degrees over proof) in the proportion of 5 lbs. of the former to one gallon of the latter. Rosin and naphtha in varying proportions are sometimes used in the cheapest grades of knotting but they have a very bad effect upon the work.

Spirit Varnishes.—Spirit varnishes are made by dissolving soft gums in alcohol. This is usually done by agitation, and in some cases with the addition of heat, as, for example, the vessel containing the gum and spirit is made to revolve in a water bath.

Varnishes.—Varnishes are too well known to need detailed description. They may be divided into three classes, namely, oil varnishes, spirit varnishes, and water varnishes. The first of these is by far the most important. In addition to the three named, natural varnishes, such as are produced by various trees found in China, Japan, and India, may be included, but these are usually termed "lacs."

Oil varnishes are made from linseed oil, gum resins, driers, and a solvent, such as turpentine or white spirit. The gums, which are mostly fossil resins, are first melted and then mixed with boiled oil; the driers are added, and on the mixture cooling, the turpentine or its equivalent is added to thin the varnish as required. Speaking generally, the hardest gums are the most difficult to melt, but they produce the best and most durable varnishes and are mostly used for fine carriages, front doors, and in positions requiring a resistance to hard wear. Nearly all varnishes, however, are made from an admixture of gum resins such as copal, kauri, dammar, amber, etc.

Under the head of "Prices for Painters' Materials" is a list of the principal varnishes stocked, and the list prices for materials of good quality.

White Enamel.—This class of paints has increased very considerably in use during the last few years, and will doubtless remain popular for many years to come. The best grades consist of pure zinc oxide mixed in a certain manner with either "stand oil," a specially treated linseed oil of high grade, or with varnish, and in some cases both. They are made in two grades—those which dry with a high gloss, and those which dry without gloss. Strictly speaking, the latter cannot be regarded as true enamels. The price varies from about 9*s.* 6*d.* to 21*s.* per gallon. As fully explained elsewhere, the success in enamelled work depends very largely upon the undercoats, and if these are defective good results cannot be obtained, however good the quality of the enamel may be.

Miscellaneous Materials.

Decorators' Soap.—The vast importance of obtaining a perfectly clean surface before repainting is apparent, and the free use of good soap and clean water will effect this in most cases. In dealing, however, with dirty work, and also to facilitate operations in an ordinary job, special soaps are made for the use of painters. These are sometimes called "sugar soaps," and other times "decorators' soaps." They are mostly used dissolved in warm water.

Flat Washable Wall Finishers.—There have lately come into the market a number of paints which are applied to walls and give an excellent flat finish which may be washed down. When thoroughly dry and hard, these paints may be regarded as being something of the nature of flat enamel—that is to say, they are superior to ordinary distemper, finer than washable water paints, but by no means so expensive as ordinary flat enamel. They are recommended for use also on ceilings, particularly those which have much embellishment in the way of ornamental fibrous plaster, etc., as the coat is thin, the details of the ornament are not lost.

Glue and Size.—The original glue and size is the gelatinous matter obtained from skins, hoofs, bones, etc. Size contains a considerable amount of water in addition. Although many painters appear to pay but small attention to the quality of the size they use, it is really of considerable importance, as any impurities, such as alkali or acids, may be contained in it, which may have a very serious effect upon the paint. Concentrated size, which practically consists of glue ground up to powder, is recommended for saving time in use. Size is sometimes used upon work mixed with a little white lead, which is termed "sheep skin." It is at the best a makeshift, and should never be allowed in good work.

Luminous Paints.—This paint does not, as might be imagined, contain phosphorus or any substance of a similar nature, but is made in such a way that it absorbs light during the day, and gives it off at night in the dark. It is used for many purposes, such, for instance, as painting lifebuoys, marking stones outside stables in the country, for signs, etc. In the Boer War it was employed by

being applied to tape, which the soldiers carried to guide them in the dark when they were making forced marches and could not use lights in the ordinary way. Many so-called failures have been made by those who have used this paint without understanding its nature. Unless it is exposed to a more or less strong light, it cannot absorb the necessary light rays, and give them off when it is dark. It would be useless to employ it in a well-lighted thoroughfare. It is important to remember that until the eyes become accustomed to the absence of light they cannot see the rays given from luminous paint. For instance, if one were to come from a well-lighted street and go into a dark room, it would be a few minutes before the luminous paint would show up to its full advantage.

An instance of its usefulness may be given in the following case. Luminous paint was used to paint advertisements standing in a field adjacent to a railway. It was not, however, by any means a success. It is true the board was exposed to the light during the whole of the day, but the intention of the advertiser was that the board should be seen by the travellers in passing trains. Inasmuch, however, as these trains were always well lighted, the eyes of the passengers were not in a condition to receive the light rays from the advertisement. On the other hand, to those who had walked in the dark through the field, and whose eyes had, therefore, become accustomed to the absence of light, the advertisement board showed up to great advantage. Luminous paint should be applied thickly, but it is well to consider it as having little or no body, and therefore it is advisable to provide such body on the undercoats.

Non-Poisonous White Paints.—During the last ten years or so there has been a very vigorous agitation, in favour of non-poisonous paints, and this has led to manufacturers producing various grades of white paint which vary in quality, the best being pure zinc oxide ground in linseed oil, while the others consist principally of lithopone. When it is desired to purchase best white paint which will be perfectly safe to use outside, pure zinc oxide should be specified, and if a little varnish is added to the final coat it will be found to stand for a considerable time.

Pumice Stone.—This material is largely used by painters to rub down the surface of paint, and prepare for subsequent coats. Small pieces smoothed on one side are usually employed, and water is employed with it. In the best class of work finely powdered pumice stone is used by means of a pad. For best work composition blocks are often employed. These are found to be economical in use, while the shape is a distinct advantage.

Putty.—Ordinary glaziers' putty is made of a mixture of fine whiting (chalk, *i.e.*, calcium carbonate) from which silica and other impurities have been extracted by levigation, and of pure raw linseed oil, the two being ground together. In order to produce a good putty, it is important that the whiting be quite freed from moisture, and to ensure this in modern methods the whiting is passed through a stove and delivered direct to the grinding mill. Ground marble dust and ground oyster shells are sometimes used in inferior putty, but a much more serious adulteration is that of using inferior oils, such as the petroleum products or fish oils, which often have the effect of causing a great deal of trouble and staining paint which is applied over the putty.

An impression appears to prevail that putty being, so to speak, an article of minor importance, no particular care need be taken as to its selection; this is quite a mistake. Very often linseed oil "foots," or the residue from pure linseed oil obtained when the oil is allowed to settle, is used in putty, and this, if employed in moderate quantities, is not objectionable, the mucilage contained aiding the binding qualities. Sometimes a little cotton seed oil is added to putty, particularly when it is used in very hot weather, and this is a general custom when exported to tropical climates. Good putty can be recognised by the manner in which it adheres. When manipulated by the hands the heat will make it soft and pliable, and if it breaks short is probably of little use.

Not only is putty used for glazing, but it is also employed largely for stopping wood and other work, to bring it to a level surface and eliminate inequalities. For this purpose equal quantities of dry white lead are added to ordinary oil putty, together with a very little litharge. These are beaten together with a mallet or piece of

wood, and then give a very hard stopping. It is not advisable to buy this ready made, as it might harden before using. Hard stopping, however, can be obtained specially prepared in dry powder, and can then be mixed as required. Sometimes a mixture of dry white lead, white lead in oil and a little ordinary putty is employed, but a little goldsize should be added to bind the parts together. A first-class putty is made from the best gilders' bolted whiting and raw linseed oil, and sometimes a little rye flour is added to prevent shrinkage. Special putties are made for greenhouses, skylights, etc., and the following is a recipe which may be employed for putty for this purpose :—

$1\frac{3}{4}$ gallons	Raw linseed oil.
15 lbs.	Gilders' whiting.
5 "	Dry white lead.
1 "	Silica.
1 "	Litharge.

A marine putty which will harden under water, can, according to Scott, be made with the following mixture :—

15 lbs.	Commercial whiting,
10 "	Portland cement,
10 "	Sublimed white lead,
5 "	Litharge,

and a little less than one gallon of boiled linseed oil.

It may be well to repeat that putty stopping must always be done after, not before, the priming coat, as otherwise the oil will be extracted by the absorbent nature of the wood or other material to which the paint is applied. In order to prevent errors in ordering ordinary putty, care should be taken to specify pure linseed-oil putty. It is not sufficient to merely state that it is to be oil putty, as any oil may be used in such a case.

Ready Prepared Paints.—The prejudice which has long existed among architects and painters as to the use of ready prepared paints, *i.e.*, paints supplied ready for use, is slowly dying. The objections urged against them are:—(1) That the owner or architect who specifies them has no guarantee as to their com-

position; (2) that they deteriorate when kept for any length of time; and (3) their composition being uniform no opportunity is given for varying it to meet the requirements of different surfaces.

The answers to these objections are:—As to the composition, this is carefully worked out by the manufacturers who practically design the paint. It is to their interest to keep up the quality of any particular brand, and the introduction of inferior material would quickly destroy their trade. Most makes of ready prepared paints do deteriorate if they are kept for a considerable time, but this is met by calling upon the contractor either to purchase direct from the manufacturer or to take means to ensure that no stale paints are used. With regard to the third objection, it is true that different surfaces require different paints; but taking wood, such as pine as an example, the condition of the wood is in perhaps nine cases out of ten what may be termed normal, and the composition of ready prepared paint would be one suitable for that condition. If, however, the surface is unusually absorbent more oil and turpentine can be added to the paint, according to the requirements of the particular job.

The following recipes were drawn up by the Dakota Agricultural Board and were intended to be the forms of labels, and also, of course, to be followed in making the paints:—

Outside White.

30	per cent.	Lead carbonate or white lead.
20	"	Zinc oxide.
5	"	Barium sulphate.
5	"	Silicate magnesia.
35	"	Linseed oil.
5	"	Turpentine japan drier.
100	"	

Tints (Not Solid Colours).

10·0	per cent.	Lead carbonate or white lead.
5·0	„	Lead sulphate.
20·0	„	Zinc oxide.
10·0	„	Silicate of alumina.
*15·0	„	Colouring material.
35·0	„	Linseed oil.
3·5	„	Japan drier.
1·5	„	Water.
100·0	„	

* Analysis of colouring material:

Yellow ochre	80	per cent.	Silica and silicates.
	20	„	Ferric oxide.
Lamp-black	98·6	„	Carbon.
Chinese blue	100	„	Ferric ferro cyanide.

Solid colours made from a combination of pigments and having a white base:—

Inside White.

7·5	per cent.	Lead carbonate or white lead.
7·5	„	Lead sulphate.
35·0	„	Zinc oxide.
5·0	„	Silica.
5·0	„	Calcium carbonate.
20·0	„	Linseed oil.
18·0	„	Turpentine japan drier.
2·0	„	Water.
100·0	„	

FLOOR PAINT.

8·2	per cent.	Ferric oxide.
30·0	„	Silica and silicates.
5·7	„	Calcium sulphate.
30·8	„	Varnish.
17·0	„	Turpentine japan drier.
7·9	„	Linseed oil.
0·4	„	Water.
100·0	„	

ROOF AND BARN PAINT.

24·48	per cent.	Ferric oxide.
31·50	„	Carbonates lime and magnesia.
4·02	„	Silica and silicates.
33·68	„	Linseed oil.
5·12	„	Turpentine japan drier.
1·20	„	Water.
100·00	„	

Rotten Stone and Putty Powder.—Rotten stone is very finely divided silica obtained from the decomposition of sandstone. It is very useful for polishing. Putty powder (oxide of tin) is used for the same purpose.

Scumbles.—These paints are used when portions are to be removed exposing the colour beneath, as in brush graining. This term refers to a cheap method of graining which is done by applying a graining colour over the usual ground colour, and then drawing a brush which is nearly dry over the surface, which removes a portion of the graining colour and gives a pleasing effect. In recent years however, certain special materials have been brought out by the

use of which many different effects may be produced which are very pleasing, and moreover, quite cheap. They are particularly suitable when ordinary graining is objected to on the ground that it is an imitation. One of the most important of these materials is "Matsine"; it is made in thirteen colours, and as the ground colour may be varied almost without limit, it will be seen an immense number of different effects may be produced without difficulty. To give a single example, on a white ground a very dark matsine is applied. A brush is then drawn over it, leaving minute streaks of white showing, producing what is known as a silver grey. There are many other materials of the kind now made, and they are all very effective if judiciously used.

Stains.—For our present purpose, stains may be divided into four classes—water stains, spirit stains, oil stains and varnish stains. They may be used either for the purpose of giving a superior appearance to inferior wood, such as white wood being made to imitate oak, mahogany, etc., or they may be employed in dull colours, such as red, green, or blue, producing a decorative effect. When wood contains many knots it is unsuitable for staining, but when the grain possesses some beauty it will be brought out by the application of stain. Soft, sappy parts of the wood, as well as such knots as exist, should be covered with bleached shellac knotting before the work proceeds.

In making water stains, ammonia and beer is sometimes mixed with it, and it is usual to add a little size for painting purposes. The colours used in water are mostly of vegetable origin, and include aloes, brazil wood, walnut peel or extract, madder, fustic, chips, indigo, cutch, and annatta. For the imitation of oak, Bismarck brown may be used, and if mixed with aniline blacks and yellows, good walnut stain may be produced.

A very simple method of staining where the colour is not objected to is to use bichromate of potash dissolved in cold water. This may be of any strength desired, and may be applied to the bare wood, and afterwards be sized and varnished.

Another very useful material for staining floors, etc., is black japan, not Brunswick black, and this may be thinned if desired to any consistency, turpentine being employed for the purpose. If

wished, colour may be added, but this of course will only give a dead sombre hue, and nothing like a bright colour can be attempted by these means.

Vegetable Size.—Of late years the vegetable sizes have grown very much in favour among decorators, because they possess considerable advantages over the variety produced from animal refuse. The vegetable sizes are free from odour, and will keep without deteriorating practically any length of time. They are somewhat more expensive than the ordinary size, bulk for bulk, but are economical in use. They are white opaque in colour, therefore do not discolour the distemper with which they may be mixed.

Washable Water Paints.—These paints have increased enormously in use during the last few years, and are made in a large variety of colours. They possess the quality of being more or less washable after they have been applied for a few weeks. Some varieties, however, cannot be said to be in any sense washable, but are little better than ordinary distempers. Washable water paints are now supplied in three different forms, namely, in powder, in paste, and in a condition ready for use. The powdered form has the objection of requiring a little time to get water to amalgamate with it, and some varieties are best made by adding hot water. The paste form is the favourite, and this is mixed by merely adding water and breaking up the stiff paste to the required consistency. Care must be taken that it is not too thin or it will not colour properly. In some grades, a special thinner called petrifying liquid is used instead of water, and has the property of considerably increasing the durability and resistance to moisture. Most of the best water paints are made on a base of lithopone (*q.v.*). These paints or distempers are not only useful for decoration purposes in place of wall paper, but may be used successfully as undercoats for oil paint when a cheap and durable job is required, and are also extremely serviceable in preventing blistering.

Duresco.—The first of the washable water paints, which are now used to such an enormous extent, was Duresco, which was invented some forty years ago. It is used in conjunction with silicate petrifying liquid, which is its recognised thinning medium. This liquid possesses excellent qualities in the way of petrifying, harden-

ing and preserving stone, brick, plaster, etc. Mixing Duresco, as a rule a hundredweight would require two gallons of the petrifying liquid. Water should not be added excepting in very special circumstances. After each coat is dry, any parts that appear sunk in should be touched up with Duresco mixed with silicate petrifying liquid, and when a uniform surface is obtained, a second coat of Duresco may be applied.

It may be also used most successfully as priming for oil paint and enamel.

CHAPTER II

CONDITIONS WHICH DETERMINE THE ECONOMIC VALUE OF THE PAINT

SPREADING CAPACITY.

IN addition to the actual durability of a paint there are several other conditions which affect its economic value; the first of these is its *spreading capacity, i.e.*, the area a given quantity by weight will cover when mixed into a paint of the usual consistency. This quality varies largely with different pigments; for example, red lead covers but little more than one half the surface covered by the same weight of zinc oxide. The spreading capacity is very easily determined with sufficient accuracy for all practical purposes by the following method:—Mix a small quantity of each pigment to be tested, thin to the proper consistency, and strain. Take two twelve-inch boards, carefully stop and prime them, then take a clean brush and paint out the two mixtures on the two boards, marking each so as to distinguish one from the other. Continue to apply the paint until it is all used up in each case; then measure the number of feet in length covered, and a comparison will at once be obtained. It is well to have a standard for comparison, and as white lead is so largely used, this may be used on one of the boards, and a comparison made with it. It will be observed that in this test alone, one pigment may be much more valuable than another, as in the example mentioned, a hundredweight of zinc oxide will spread, approximately, twice as far as a hundredweight of red lead, so that twice as much of the latter will be required for a given job of painting as the former. Obviously then, the quality of spreading has an important bearing on the economic value of the paint.

It is impossible to give exact figures for a spreading capacity of all the principal pigments, because a great deal will depend upon the quality, fineness of grinding, the amount of oil necessary for making a paint, and other details. The table which follows gives the results of careful experiments made by the author, the late Mr. George H.

Hurst, Mr. J. Cruickshank Smith, the well-known paint expert, and various other authorities which have been consulted.

The author's experiments were conducted in the manner just described, namely that of painting twelve-inch boards, and in cases where his figures differ considerably from those given by other writers, he conducted his experiment a second time. All of the figures given must be taken to be approximate, because the actual thickness of a paint film varies very largely, and even in the same coat it is by no means of the same thickness throughout. A practical working painter of skill and experience would probably feel insulted if it was suggested that he could not apply a coat of paint quite evenly to a primed surface. The writer has known many men who have been loud in their claims that they could brush on paint quite evenly and uniform in thickness, but he has been able to very quickly bring them to reason by asking them to paint a sheet of transparent white celluloid. When this is done and the celluloid is held up to the light, the imperfections are at once discovered, and it is remarkable to note how great a variation is to be found in different parts of the sheet. Even when the surface viewed from above looks quite uniform, it will, when held up to the light, show streaks of great solidity and other parts which are hardly covered at all. This is referred to again elsewhere under the head of "Paint Spraying."

Table showing the Spreading Capacity of Different Paints on Non-Absorbent Surfaces.

The following figures represent square feet covered by 10 lbs. of paint of the usual consistency, applied evenly with a brush.

On Wood.

	1st Coat.		2nd Coat.	
	Jennings.	Hurst.	Jennings.	Hurst.
Red lead	120	112	248	252
White lead	225	221	320	324
Oxide of zinc	380	378	450	453
Red oxide	450	453	520	540
Raw linseed oil (no pigment)	750	756	832	872
Boiled linseed oil (no pigment)	430	412	525	540

ON METAL.

	Coats nearly Equal in Composition. Jennings.	Hurst.
Red lead	462	477
White lead	623	648
Oxide of zinc	1,090	1,134
Red oxide	862	870
Raw linseed oil (no pigment)	1,398	1,417
Boiled linseed oil (no pigment)	1,275	1,296

SPREADING CAPACITY TABLE OF READY-MIXED PAINTS, UNDERCOATS, VARNISH AND ENAMELS.

	Per gallon.
Ready-mixed paints in oil—	
First coat on wood or plaster	50 to 55 sq. yds.
Second coat on wood or plaster	60 „ 65 „
Finishing coat on wood or plaster	75 „ 85 „
Ready-mixed paints in turps—	
When used on an oil coat	85 „ 90 „
Undercoating ready for use—	
The ordinary "flatting" type	85 „ 90 „
The "flowing out" type	75 „ 80 „
"Paste" undercoatings to thin with turps—	
7 lbs. requires 1½ pints turps, and covers	35 „ 40 „
Varnish	
The easy bodied type	90 „ 100 „
The full bodied type	85 „ 90 „
Enamel, flat and gloss—	
The easy bodied type	75 „ 80 „
The full bodied type	70 „ 75 „
Water paints, paste—	
7 lbs. reduced on bare plaster	30 „ 35 „

The same figures apply to the finishing coat. There is less suction, but the material is used more "round." The variation in the figures relating to oxide of iron is probably due to entirely

different qualities of oxide being experimented with, as in this pigment there is a vast difference of quality in different makes. It may be mentioned that the spreading capacity of gypsum is very high, by which it might be thought that on account of that it would form a very economical paint, whereas the fact is that exactly the contrary is the case because it is almost wholly deficient in body. This is a very good example which shows the necessity of taking all the qualities together in determining the value of a paint.

Body.

This is one of the most important qualities of a paint; it means literally the opacity or power of hiding the surface to which the paint is applied. In painting a door, for example, it is usually deemed necessary to give a sufficient number of coats to entirely hide the grain of the wood and the knots. When white lead is used three coats usually effect this completely. If a pigment is deficient in body, one or more additional coats will be needed to effect the same object, so that expense would be considerably added to. The well-known adulterant of white lead, sulphate of barium, usually known as "barytes," is very deficient in body, and the writer has had it ground in oil, and applied as many as ten coats to a wooden surface without hiding the grain and the knots. If it were not for this fact barytes would make a very good paint, as it is quite inert and is not affected by sulphur fumes, by acids or by alkalies; but its transparency is fatal to its use alone as a paint. The same is true of gypsum, and many other adulterants. White lead possesses excellent body, although, as already pointed out, other pigments are superior, as, for instance, lithopone.

As intimated in Chapter I., a small proportion, say, from 5 to 10 per cent., of barytes added to white lead is no detriment, but probably an actual advantage. This statement will probably surprise many readers who have hitherto looked upon pure white lead as being the acme of perfection in paint material. As a matter of fact, if 5 to 10 per cent. of barytes is added to white lead the quantity is not sufficient to seriously interfere with the body, so that only the same number of coats will be required, while the

inertness of the barytes will add to the durability of the paint. Such a proportion would somewhat lessen the cost. White lead when pure is sold as "genuine" and when adulterated as "reduced." Unfortunately, however, the proportion of the added material varies with different makers so that the composition of the reduced white lead of one maker might contain much more or much less barytes than that of another. Engineers and architects, therefore, who agree with the writer that a small proportion of barytes added to the white lead is an advantage, should be careful to specify precisely what that proportion should be, and it should rarely exceed the 10 per cent. limit.

A curious property of zinc oxide may be mentioned here in connection with its body. It being quite innocuous, many of those interested in painting are anxious that it should take the place of poisonous white lead; but against its general adoption it is urged that while its spreading capacity is excellent it is deficient in body. The curious quality referred to is this—when boards are painted out side by side, one with white lead and one with zinc, the first coat is certainly not so good as the lead, and the second coat they are nearly equal, with a slight advantage in favour of the lead; in the third coat, however, they are quite equal, and if there is an advantage it is in favour of the zinc. These results have been obtained by the author many times as the result of careful experiment, and Mr. J. Cruickshank Smith was, it is believed, the first writer to direct attention to this important phase of the subject.

To ascertain the body of the paint, the following simple experiment may be conducted.

Prime a board and give it one coat of white paint; then paint across it with black stripes, say one inch in width. When quite dry mix the paint to be tested to the usual consistency, taking care not to add too much turpentine or oil, and with a clean brush paint over the whole surface at right angles to the stripes, leaving, however, about an inch at one end unpainted. When this coat is dry give a second coat, leaving an inch or more of the first coat exposed. Afterwards give a third and a fourth coat, in each case leaving a portion of the coat beneath exposed. Paint possessing good body

will entirely obscure the black stripes on the third coat, and on the second the black will hardly be discernible.

In all practical paint tests, it is, as already mentioned, very advisable to have a standard of comparison, and in this case we may well take white lead as the standard, painting a second board in precisely the same way as the one described. When these are placed side by side, a comparison can readily be made by comparing one with the other. The zinc sulphide paints, or lithopones, will be found to possess, as already mentioned, a very good body indeed. It will be useful, too, to experiment in the same way with pigments ground in different vehicles, as it will demonstrate very clearly the remarkable difference in the various thinners employed. For example, common chalk or whiting, when mixed with water, which, of course, forms the basis of ordinary distemper, will be found to possess excellent body, but if it is ground in oil its body will be practically *nil*. Some of the colours may also be experimented with, when it will be found that there is a very great difference between them so far as the quality of body is concerned. Venetian red, and the oxides of iron generally, will be found to possess as a rule very good body, while Prussian blue and all the lakes are very deficient in this quality, so much so that the latter class of pigments can only be used in practical house painters' work as glazes, *i.e.*, as a thin glazing coat to give brilliancy over a more sombre but solid colour.

Fineness of Grinding.

This quality of a pigment determines its durability to a far greater extent than is generally recognised. A large number of experiments conducted on a scientific basis, as well as practical experience, have proved that the life of a paint is added to, almost proportionally with the degree of fineness to which it is ground. A very coarse white lead, for example, will not last more than, say, one-fourth as long as one which is finely ground, yet, strange to say, very few engineers or architects have anything in their specifications relating to this important quality. Two instances may be given to

prove that fineness of grinding and lasting qualities go hand in hand. Lamp black, which is made from the soot obtained by burning refuse oil, is naturally in a very fine state of subdivision, and lamp black when ground in oil to make paint is exceedingly durable, even when exposed to the most severe weather. Every reader must have seen from time to time signposts at cross roads, which have perhaps not been repainted for many years, and have noticed that while the white lead ground has almost, if not quite, disappeared, the black lettering remains almost unimpaired. This is doubtless due to some extent to the quantity of oil used in grinding the black, but principally to fineness. Again, grained work, although not very popular just now from an artistic standpoint, is without doubt very durable indeed, and one occasionally comes across a room in some old-fashioned house which was grained perhaps forty or fifty years ago, but still retains its beauty, notwithstanding its long wear. The explanation is that the grainers' colours, such as ochre, sienna, umber, etc., must all be very finely ground, or good graining could not be done with them, and this has much to do with their extreme durability.

To test a paint for fineness of grinding is by no means difficult, and here again a standard of comparison must be used. The simplest way is to take two tall cylindrical glass vessels, and place in them water, if the pigments to be tested are in the form of a dry powder, or turpentine, if they are ground in oil. Weigh an equal quantity of each pigment and place one in each vessel and stir thoroughly, then watch the rapidity with which the pigment settles. By making marks on the glass a very accurate comparison between the two pigments can be made. It must, however, be remembered that the standard of comparison must be with a pigment similar to that which is being tested. Thus, one white lead can be compared with another, or one zinc with another zinc, but it would not do to make a comparison between different pigments by this test, as the specific gravity varies so considerably.

The painters' old-fashioned test is to place a little of the pigment on the thumbnail, when any grittiness will be apparent by rubbing the other nail over it. A better plan to ascertain the fineness of, say, six different grades of white lead, is to thin out each with

exactly the same quantity of turpentine, and then to paint out each, using a separate clean brush in each case, on a sheet of plate-glass, when the fineness will be apparent by passing the fingers over the surface. The microscope is also of very great service in this connection, and the testing departments in paint works are now always provided with an instrument to test samples received as to their fineness. The fact must not be overlooked that the grinding of a pigment costs money, and naturally a coarse one can be sold at a much lower price than one which is finely ground. The actual size of particles of different pigments varies considerably and modern investigation tends to favour a mixture of pigments, on the assumption that when a pigment which is naturally very fine is mixed with one that is coarser, the former particles fill up the interstices of the latter, on the same plan that is followed in making concrete where the spaces between the stones derived from the gravel are filled up with smaller stones and sand, the whole being united with Portland or other cement which corresponds with the linseed oil in a paint.

A useful test for fineness of grinding is to add colour to the different specimens. For example, if it were wished to ascertain by this test the fineness of an unknown white lead submitted for examination one would take the standard, a small quantity of a lead well known to be finely ground, weigh out a small portion and add a very little black. Then we should take precisely the same quantity of the lead under examination and add to it precisely the same amount of black as before. Add a few drops of oil to each, taking care that the quantity of oil is the same in both cases and mix up each with a palette knife. The mixture which is the lightest of the two indicates that that specimen is the finer ground. At first sight this appears a little difficult to understand, but the result will be clear when it is considered that the smaller the particles are the greater is the surface which is to be coloured. The writer has many times watched the process of making coloured mortar by machinery, and has noticed how apparently the colour disappears as the grinding proceeds. If we imagine that each particle is a rough cube, say, for the sake of example, of one inch side, we shall clearly have six square inches of surface to colour. If the grinding breaks up these cubes into half-inch cubes we then have eight cubes, each having a

face of half a square inch or a surface of $1\frac{1}{2}$ square inches in each cube, and twelve square inches in all, which are to be coloured. This simple analogy explains the rule that the finer a pigment is ground the more colour will be required to colour it to a given tint.

THE COST OF THE MATERIAL.

The prime cost of paint varies considerably from time to time according to the fluctuations of the market in those materials of which all paints are more or less composed, such as linseed oil, turpentine, white lead, etc. In considering the relative cost of different paints we may ignore the price of linseed oil because whatever pigment is employed the cost of the linseed oil will be approximately the same, no satisfactory substitute for it having thus far been discovered. It is true that some pigments require very much more oil than others, but this is an item which concerns the paint manufacturer rather than the engineer or architect.

As a guide to the comparative cost of different paint materials, and in order to give the reader a basis for working out according to the value of the tables which follow, we give a tabulated statement of average prices current. They are higher than would be expected in the case of large orders being given by a railway company or a corporation, or other large purchasing body, but a fair average price in moderate quantities of first-class materials in their respective grades. The list includes several materials which can hardly be said to form a necessary part of paint or painted work—for example, varnish—but they are given in this table for the convenience of reference.

It should be distinctly understood that the prices of white lead, zinc oxide, linseed oil, turpentine, and many other materials mentioned below fluctuate considerably from time to time, and allowances must be made accordingly. The prices of some of the materials mentioned may be found in the leading daily papers. *The Oil and Colour Trades Journal*, published weekly, gives current prices for most painters' materials.

AVERAGE COST OF MATERIALS.

		s.	d.
White lead (genuine, dry) . .	per cwt.	25	3
White lead (genuine, in oil) . .	„	32	0
White lead (reduced, in oil), average	„	28	6
White paint (according to reduction) .	„	25	0
Lithopone, in oil	„	24	0
Oxide of zinc (genuine), in oil . .	„	36	0
Oxide of zinc, No. 1	„	34	0
Oxide of zinc, No. 2	„	31	0
Red Lead	„	25	0
Orange lead	„	36	0
Tinted paints, still in oil (Note such colours as drab, French grey, buff, slate, stone, silver grey, etc., are usually supplied all at the same price.)		26 0 to 30 0	
Best Indian red, in oil, genuine . .	per cwt.	36	0
Indian red paint	„	28	0
Best Venetian red, in oil . . .	„	32	0
Permanent red	per lb.	2	0
Royal red	„	1	6
Fast red	„	1	9
Turkey red, in oil	per cwt.	42	0
Oxide of iron, in oil, best . . .	„	28	0
Purple brown, in oil	„	32	0
Chocolate, in oil	„	24	0
Ultramarine blue, in oil, best . .	per lb.	1	0
Prussian blue in oil, best . . .	„	2	0
Best yellow paint (stiff, in oil) . .	per cwt.	26	0
Best staining yellow ochre, in oil .	„	36	0
Chrome, genuine, in oil . . .	„	56	0
Yellow paint for graining . . .	„	36	0
Raw sienna, in oil	per lb.	0	6
Burnt sienna, in oil	„	0	9
Brunswick green paint, best, in oil .	per cwt.	36	0
Bronze green paint, best „ .	„	40	0
Chrome green paint, best „ .	„	42	0

		s.	d.
Emerald tint green paint	per cwt.	56	0
Engine green paint	,	32	0
Zinc green, in oil	,,	60	0
Quaker green	per lb.	0	9
Black paint, stiff, in oil	per cwt.	22	6
Drop black, in oil	per lb.	1	0
Vegetable black	,,	1	0
Drop black in turps	,,	1	0
Raw Turkey umber, in oil	per cwt.	36	0
Burnt Turkey umber, in oil	,,	48	0
Putty ground in best linseed oil	,,	8	6
Best patent driers	,,	28	0
Zinc driers	,,	56	0
Gilders' whiting	,,	2	0
Enamels, best	per gallon	21	0

VARNISHES.

French oil	,,	21	0
Best finishing body varnish	,,	24	0
Best hard body varnish	,,	20	0
Best flatting varnish	,,	16	0
Best pale elastic carriage varnish	,,	16	0
Paper varnish (white copal)	,,	20	0
Crystal paper varnish	,,	12	0
Elastic superfine black Japan	,,	14	0
Black enamel	,,	12	0
Best Japan gold size	,,	10	0
Coburg varnish	,,	28	0
House painters' copal varnish	,,	14	0
Pale oak varnish	,,	12	0
Quick drying furniture varnish	,,	16	0
Brunswick black	,,	8	0
Genuine Berlin black	,,	12	0
White knotting varnish	,,	12	0
Pale French polish	,,	8	0
Quick drying copal varnish	,,	14	0

		s.	d.
Fine hard oak varnish	per gallon	10	0
Pale terebine	,,	12	0
Best pale mastic varnish	,,	40	0
Matt varnish	,,	20	0
Egg shell gloss varnish	,,	18	0
Linseed oil	,,	2	6
Turpentine, genuine American	,,	3	0
Turpentine, Russian deodorised	,,	2	6
Blended turpentines	,,	2	0
White spirit	,,	1	6
Aluminium paint	,,	18	0
Finest oil colours (in collapsible tubes, large size):—			
Antwerp blue		1	0
Blue black		1	0
Brown ochre		1	0
Burnt sienna		1	0
Burnt umber		1	0
Carmine		2	0
Cobalt blue		2	0
Chrome green light		1	0
Chrome, green middle		1	0
Chrome green, deep		1	0
Chrome yellow, pale		1	0
Chrome yellow, deep		1	0
Chrome orange		1	0
Cremnitz white		1	0
Crimson lake		2	0
Chinese blue		1	0
Dutch pink		1	0
Emerald green		1	0
Flake white		1	0
Indian red		1	0
Ivory black		1	0
Italian ochre		1	0
Lamp black		1	0
Light red		1	0

	s.	d.
Finest oil colours—*continued.*		
Madder lake	2	0
Oxford ochre	1	0
Permanent white	1	0
Prussian blue	1	0
Prussian brown	1	0
Purple lake	1	6
Raw sienna	1	0
Raw umber	1	0
Scarlet lake	1	6
Sugar of lead	1	0
Terra verte	2	0
Transparent gold ochre	1	6
Ultramarine, light	1	0
Ultramarine, deep	1	0
Vandyke brown	1	0
Venetian red	1	0
Verdigris	1	6
Vermilion, light	2	0
Vermilion, deep	2	0
Yellow lake	1	0
Yellow ochre	1	0
Zinc white	1	0

Cost of Labour.

Neglecting for the present paint applied by dipping or spraying, which is dealt with in another chapter, we may now consider the cost of applying paint by means of an ordinary brush. It may be taken as a general rule, upon which to base estimates, that a practical painter can paint in one hour one yard of three-coat work on an ordinary surface, or one yard of coat of flatting or enamelling. The cost then per yard of three-coat work irrespective of material can readily be ascertained from the wages current in the particular locality in which the work is to be done.

The following is the rate of wages paid to painters in some of the

principal localities throughout the United Kingdom, which may be roughly summarised as follows :—

6*d.* *per hour.*—Driffield, Nantwich, Lichfield, Colchester, Lowestoft, Wendover, Yarmouth, Chichester, Seaford, Bridgwater, Dorchester, Taunton, Keith and Isle of Man.

6½*d.* *per hour.*—Grantham, Pershore, Cambridge, Chelmsford, Ipswich, Norwich, Wellingborough, Bideford, Goole, Sandbach, Lurgan, Andover, Ashford, Isle of Thanet, Dartmouth, Exeter, Isle of Portland, Weston-super-Mare, Elgin, Peterhead, Barnstaple.

7*d.* *per hour.*—Keswick, Crewe, Bromsgrove, Hinckley, Kidderminster, Lymington, Loughborough, Malvern, Abergavenny, Beverley, Kendal, Oldbury, Stourbridge, Warwick, Scunthorpe, Wellington, Oxford, Romford, Southend - on - Sea, Reading, Rochester, Woking, Forfar, Stroud, Douglas, Bath, and Eastbourne.

7½*d.* *per hour.*—Penrith, Selby, Blackwood, Chesterfield, Kenilworth, Leamington, Gloucester, Nuneaton, Plymouth, Portsmouth, Tamworth, Worcester, Londonderry, Grimsby, Scarborough, Leek, St. Albans, Caterham, Folkestone, Gravesend, Redhill, Reigate, Tunbridge Wells, Colwyn Bay, Merthyr-Tydvil, Pontypridd, Inverness, Torquay, Portsmouth, Dewsbury, Doncaster, and Newark.

8*d.* *per hour.*—Berwick-on-Tweed, Hartlepool, Southampton, St. Annes, West Bromwich, Wolverhampton, Leeds, Aberdare, Brighouse, Dumfries, Darlington, Barnoldswick, Sheffield, Spen Valley, Sowerby Bridge, Buxton, Leicester, Aberdeen, Derby, Dartford, Lincoln, Mansfield, Newport, Rugby, Rotherham, Stirling, Cork, Keighley, Macclesfield, Cheltenham, Lincoln, Harrogate, and Huddersfield.

8½*d.* *per hour.*—Jarrow, Newcastle-on-Tyne, Barrow-in-Furness, Bury, Darwen, Southport, Stalybridge, Nottingham, Smethwick, Alnwick, Blackpool, Bradford, Barry, Chester-le-Street, Gt. Harwood, Runcorn, Middlesbrough, Belfast, Stockton, Cardiff, Dundee, Edinburgh, Kilmarnock, Leith, Halifax, Burnley, Leigh, Stockport, Warrington, Bournemouth, Accrington, and St. Helen's.

8¾*d.* *per hour,*—Salford, Chester, Coventry.

9*d.* *per hour.*—Blyth, Wallsend, Airdrie, Blantyre, Clyde Bank,

Coatbridge, Glasgow, Greenock, Hamilton, Moseley, Morpeth, Middleton, Sale, Shaw, Hellinsboro', Motherwell, Paisley, Rothesay Uddingstone, Leigh, Gateshead, South Shields, Ashton-under-Lyne, and Bolton.

9½*d.* *per hour.*—London, Manchester.

These rates of wages have in some cases been slightly raised.

From the above it will be seen that the actual cost of labour in applying one yard of three-coat work will vary from 6*d.* to 9½*d.* according to the locality. To this of course must be added the cost of material and the contractor's profit, which is usually taken at 15 per cent. for new work, and 20 per cent, for old work, these sums including in both cases the cost of wear and tear of brushes, plant, etc.

When the labour is cheap, such, for example, as when unskilled workmen are employed, the cost will be correspondingly lowered, but the fact should never be lost sight of that an untrained " hand " will use more paint than one skilled in using a brush. Moreover the extra thickness of paint does not add to the durability, but detracts from it. Very many proofs could be given if necessary.

Prices for Painters' Work.

It is thought desirable to include in this work as a general guide prices for painters' work, although it must not be supposed that the prices given are hard and fast. As a matter of fact, the cost of painting work varies very largely in different parts of the country, according to the local cost of labour, and other conditions. In some places remote from the big towns low wages are the rule, but the cost is added to by the increased expense of carriage on materials. The prices below may be taken as those current in London for work of average good quality.

1. Painting.

Painting on new woodwork, etc., including preparing, stopping, and knotting before the priming coat is applied, and all necessary rubbing down between each coat as required, and all plant and scaffolding, etc., under ordinary conditions.

***Common colours*, viz., lead, white, stone, chocolate, black and ordinary green and red.**

SUPERFICIAL WORK.

	One Coat.		Two Coats.		Three Coats.		Four Coats.		Flatting (extra).	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Plain painting on wood surfaces, per yard super . . .	0	6¼	0	10	1	1¾	1	4¼	0	3
Plain painting on new plaster work	0	6¼	0	10	1	1¾	1	4¼	0	2½
Ditto on ironwork if done before fixing	0	6¼	0	10	—		—		—	
Ditto if after	0	7½	0	11¼	1	1¾	1	4¼	—	
Iron gates and railings, open, with plain or spiked tops, including stays, standards, etc., per yard super	0	6¼	0	10	1	1¾	1	4¼	—	
Plain painting with enamel paint (12*s.* per gallon) . . .	0	9½	1	1¼	1	6¾	1	10½	—	
Ditto (18*s.* per gallon) . .	0	9¾	1	2½	1	9¼	2	1	—	
Ditto (21*s.* per gallon), per yard super	0	11¼	1	3	1	10½	2	2¼	—	
Flat or glossy finish same price.										

LINEAL WORK.

	One Coat.		Two Coats.		Three Coats.		Four Coats.		Flatting (extra).	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Eaves gutters, inside and out, not exceeding 24 in. girth, including brackets, per foot run .	0	1¾	0	2¼	0	3	0	3½	—	
Rainwater soil and vent pipes not exceeding 4 in. diameter including bends and shoes, etc., per foot run	0	1¾	0	2¼	0	3	0	3½	—	
Bars, pipes, sash beads, mouldings, architraves, picture rods or rails, sash rails, etc., window boards, skirtings, handrails, lines cut in both edges, etc., etc.:—										
Under 4 in. girth, per foot run	0	0¾	0	1	0	1¼	0	1¾	0	0¾
4 in. to 9 in. girth, per foot run	0	1	0	1¼	0	1½	0	2¼	0	1¼
9 in. to 14 in. girth, per foot run	0	1¼	0	1¾	0	2	0	2¼	0	1¼
14 in. to 18 in. girth, per foot run	0	1¾	0	2	0	2¼	0	2½	0	1¾

NUMBERS.

	One Coat.		Two Coats.		Three Coats		Four Coats.		Flatting (extra).	
	s.	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*	*s.*	*d.*
Sash frames, not exceeding 25 ft. super, each	0	8¾	1	0½	1	4¼	1	10½	0	8¾
Large ditto, not exceeding 35 ft. super	0	10	1	5½	1	10½	2	6	0	10
Two-light casement frames, each	0	11¼	1	3	1	6¾	1	10½	0	11¼
Three-light casement frames, each	1	1¾	1	5½	1	9¼	2	3	1	1¼
Chimneypieces (ordinary), each .	0	11¼	1	7¾	2	2¼	3	1½	0	11¼
Sash squares, not exceeding 2½ ft. super, per dozen	0	10	1	3	1	7¾	1	10½	0	10
Ventilators, air bricks, and such like, not exceeding 1 ft. super, each	0	2½	0	3¾	0	5¾	0	7	—	

For superior colours, viz., Cobalt blues, emerald greens, madder browns, and other similar tints, add 30 per cent. on foregoing prices.

For plain painting on *old* woodwork, all the foregoing prices will apply with an addition for cleaning, stopping, rubbing down, and preparing for new paint, of 1½*d.* to 2*d.* per yard super, according to the condition of the work.

For finishing doors, panels, lining out on walls, mouldings, bands, etc., etc., in parti-colours, measure the feet run and price according to girth, as shown in foregoing prices under the heading of "Lineal Work."

BURNING OFF, ETC

		s.	*d.*
For burning off, cleaning, and rubbing down with pumice stone, knotting and facing up preparatory to receiving the first new coat of paint, per yard super		0	4
For broad surfaces	to	0	3

STAINING AND VARNISHING.

	Once.		Twice.	
Cleaning off, twice sizing, and varnishing on wood surfaces with best copal varnish, per yard super .	0	9½	1	1¾

FELTING DOWN.

If work has to be felted with pumice powder, and cleaned off before varnishing second coat, add extra, per yard super, 2*d.*

2. Distempering, etc.

	s.	d.
To washing off, stopping, claircolling, and distempering white one coat on old plastered ceilings and walls, per yard super	0	4½
If two coats, per yard super	0	5

	One Coat s.	One Coat d.	Two Coats s.	Two Coats d.	Three Coats s.	Three Coats d.
Distempering on new work (plastered ceilings or walls), with patent washable distemper, per yard super	0	3¾	0	5¾	0	7½
For French grey or other colours of a superior nature add 10 per cent. to 15 per cent.						

	s.	d.		s.	d.
For ceilings which are in a dilapidated condition a fair price to restore them would be, per yard super	0	6¼	to	0	7½
Centre pieces, not exceeding 36 in. diameter, each				3	1½

Schedule of Prices for Gold Leaf, Gilding in Oil, Japanners' Gold Size, Writing Size, etc.

Gilding.	Girth, inches.	Single s.	Single d.	Double s.	Double d.
To sizing and gilding beads, flats, etc., in oil, per foot run, ½ in. and under	–	0	2½	0	4½
Ditto, mouldings and flats, etc., per foot run, 1 in.	–	0	6¼	0	8¾
Ditto, 1½ in.	–	0	8¾	1	0½
To gilding, including all preparation, ordinary egg and dart mouldings, at per foot run	1	0	10	1	3

Plain block lettering —	Per inch— One Coat. s.	d.	Two Coats. s.	d.
1 in. and under	0	1	0	1¼
Above 1 in. and up to 12 in.	0	1¼	0	2
Average size index hands, each	0	11¾	1	3
Effacing old writing or numbers on doors, each	0	7½	—	

Expenses.

All work at a distance of more than one and a half miles from the shop to three miles to have 10 per cent. added for expenses, loss of time, etc. Above three miles and under six miles to have 15 per cent added; beyond this, the necessary railway or lodging expenses as the case may be. It is true, in a few exceptional cases, larger prices are obtainable than the foregoing, but as a general thing the prices given here reach the top note of most obtainable for ordinary plain work.

Sundries.	One Coat. s.	d.		Two Coats s.	d.
Tarring with Stockholm tar mixed with ochre or Spanish brown and pitch, per yard super . .	0	3¼		0	5
Ditto, with coal tar mixed with 1 lb. of pitch and 1 lb. of resin to 6 gallons of tar, per yard super .	0	2¼		0	3¾

French Polishing.	One Coat. s.	d.		Two Coats s.	d.
On doors and broad surfaces, per foot super . .	0	6¼	to	0	7½
Deduct if the work is only bodied in and half polished, per foot super		2½d.			
Polishing on handrails, not exceeding 12 in. girth, per foot run	0	5	to	0	6¼
Cleaning, preparing, and repolishing old work, per foot super	0	4½	,,	0	5¼
Handrails, as before, per foot run	0	3¼	,,	0	3¼
Wax polishing floors, per yard super	0	3¼	,,	0	5
French polisher, including materials, in addition to time occupied in going to and from shop and travelling expenses, per hour		1s. 3d.			

Limewhiting.	One Coat s.	d.	Two Coats. s.	d.
Limewhiting on ordinary plastered walls, per yard super	0	1¼	0	2¼
Ditto, on brick or concrete	0	1¾	0	2½

Some of the tunnels on our underground railways have recently been limewhited by means of an apparatus which, by revolving, throws the material on the walls, and, of course, where there are very large surfaces to cover, this method is a very useful one, but the prices given would not be very appreciably affected.

Cost of Water Paint as Compared with Oil Paint.

It may be interesting to give a comparison of the cost between painting a wall in ordinary oil colour, finishing with a flat surface, with the expense of finishing in a first-class water paint. If water paint is used, there will be a saving of one coat, which means a saving of 25 per cent. in material and labour.

Note.—As already stated all the above prices are based upon those current in London but at least 25 per cent. additional would be required for the highest-class work.

CHAPTER III

SIMPLE TESTS FOR PAINTERS' MATERIALS

It is not thought necessary or desirable to include in this book those tests which may be applied to paint and kindred products in order to ascertain their purity and value, because such tests can only be made by a chemist who is also a paint technologist. There are, however, a few very simple tests which can be applied by anyone who possesses no chemical knowledge whatever, and these we propose to include. In order to ascertain the nature of a pigment used in a paint, such as white lead ground in oil, it will be first necessary to extract the oil, so as to obtain a dry pigment to work upon. The sample of paint should be placed in a small stoppered bottle, and a little petrol or benzene (benzol) poured in on top of it; the bottle should be then well shaken and allowed to come to rest, when the pigment will settle, and the oil and petrol or benzene come to the top. This should be gently poured off. The process may be repeated several times until all the oil is extracted. The chemical pigment should then be placed on a saucer and allowed to dry, but as it will contain a certain amount of the spirit, it should not be brought near to a fire or light. In a little while the spirit will have evaporated, leaving a dry powder behind it.

Tinting Strength of Colours.

To ascertain the staining or tinting strength of colours is comparatively easy, although the operation is a somewhat delicate one. The following simple apparatus will be requred for the purpose namely :—a small pair of delicate scales, such as may be purchased at a chemist's for about 1*s*., some small pieces of waxed paper, two spatulas, a small bottle of linseed oil, and a little zinc white, litho-

pone, or white lead in dry powder. If neither of these are at hand in the dry form the oil can be extracted by the method mentioned above, or it will be sufficient to place a little of the colour on blotting paper, which will extract the oil to some extent. The necessity of getting rid of the oil, or the greater portion of it, is that in comparing two colours the one might be ground in much more oil than another of the same class, and therefore would not show up so well for its tinting strength. By partially or wholly extracting the oil the samples are brought to the same consistency. A sheet of glass, or a smooth piece of marble or slate, will be required to make the mixtures on.

Now, it must be clearly understood that in tests of this character, as indeed most tests with painters' materials, the comparison must be made between the particular sample under examination and that of a similar colour whose qualities are well-known. Let us take Prussian blue by way of an example, and suppose that one has been purchasing Prussian blue ground in oil for a certain price, and it has given satisfaction. Another Prussian blue is offered at a lower price, and is guaranteed to possess as good or better staining power than one already used. The aim in the experiment then is to ascertain whether this claim is justified. Two small portions of white are first weighed out, say as much as will cover a penny. They must be exactly equal, and if a little pile of white is placed on each side of the scale, more or less can be added until they balance. These are placed a few inches apart on the slab. The next thing is to take a very little, say a piece half the size of a pea, of each blue and place them with the piles of white respectively, taking care to mark which is the original blue and which the one under examination. Add as nearly as possible the same quantity of oil to each—a few drops will suffice—and then with the spatula mix thoroughly the white and blue together, using a different spatula for each. Conclude by smoothing out the paint thus formed, when we shall have two samples side by side, and a glance will suffice to show which of the two is the stronger.

It may be observed here that a good deal of the colours sold are largely adulterated with barytes; as already pointed out, this material, if used in strict moderation, does not interfere with the

durability of a paint, although it does lessen the body. When barytes, however, is added to a colour, it lowers the tinting strength in proportion to the quantity so added. Considering that barytes is white it possesses, of course, no tinting properties whatever. If, therefore, a Prussian blue is adulterated with 50 per cent. of barytes, it will require exactly double the quantity to that of pure colour to produce a given tint.

Any colour can be tested in the manner described, and the operation not only indicates the strength but also the tone or hue of the colour, which is an important consideration, particularly in the earth colours, such as sienna, ochre, etc.

Linseed Oil.

The purity of linseed oil cannot be accurately ascertained excepting by examination by a chemist well versed in such work, but taste and smell are of great help. A little oil of known purity should be poured on the palm of the hand, the two hands then rubbed briskly together, then the right hand should be placed over the left, each hand grasping the other, with an opening between the thumbs and the first finger of the right hand. The smell will then be very pronounced. Wipe the hands and immediately proceed exactly in the same way with the suspected sample, and in a moment one can judge whether the smell of the two samples is identical. A few drops on the tongue will also yield valuable information, as adulterated linseed oil usually has an acrid taste. A practical test of value is to pour a little of the suspected oil on a piece of glass and on another piece of glass a little pure oil. Do not brush out, but let the oil run down as far as it will go; of course, only a little will be used, and this may be rendered smooth by using the tip of the finger. Place in a fairly light position in a well-ventilated roon, and note how long it takes each to dry. This can be ascertained by lightly touching the surface with the tip of the first finger. When quite dry scrape the surface of each and note the condition of the small piece of film removed. The pure linseed oil will be found to be fairly tough and elastic, and to come away with a sharp clean edge; the adulterated oil, however, will most

frequently show a ragged edge where scraped, while the small portion of film removed will be more or less brittle.

VARNISH.

The different grades of varnish are mentioned elsewhere at some length, but we have now to ascertain how they may be tested in a practical manner, for it should be said at once that chemical analysis tells very little as to the durability of a varnish. Taking first the ordinary oil varnishes, and assuming that samples are put up in small bottles, the first thing to be done is to see that they are all bright. This does not necessarily mean light in colour, although of course, those required for application to light tints or white work have to be as far as possible free from colour. Some varnishes have a disagreeable muddy appearance, and should be rejected. The simplest test is very similar to that already explained under the head of "Linseed Oil." A few drops are placed on a piece of glass and rendered smooth with the tip of the finger. These are then allowed to become hard, and careful note is made as to the time the varnish takes to become tacky, *i.e.*, slightly sticky, but dust proof, and also how long it takes to become quite hard. The surface is then scraped with a sharp knife and the small portion of film examined. The cut should be clean as in the case of linseed oil, and there should be no sign of brittleness. The best plan to follow is to make tests side by side with a good varnish, so as to compare the two. Another very good plan, where time permits, is to paint out boards and expose them to the weather, in this case, taking a standard as before. It should be noted that on no account should the same brush be used for different varnishes; a clean fitch should be used for each.

Rosin is generally regarded as a bad constituent of varnish, as although it cheapens the product considerably, the result is a brittle varnish which is not durable even when used on inside work, because the least knock will give an objectionable abrasion. To discover the presence of rosin the following method may be followed: Take a piece of thick felt, saturated with water, and place it on the hard varnished surface with a fairly heavy weight on top. Allow

this to remain over night, and then examine the surface. If it is cloudy and milky in appearance, rosin is probably present. Some grades of varnish however, produce this milky appearance with whatever is brought into contact with them, but it disappears after a few hours; in the case of rosin, however, it remains more or less permanently. In the absence of the felt a sponge may be employed instead, but the weight in this case must be a very light one, or the water will all be squeezed out.

Professor A. P. Laurie, Professor of Chemistry to the Royal Academy of Arts, patented some time since an instrument for testing varnishes, or rather ascertaining the hardness and toughness of a varnish film. It consists, essentially, of a sharp steel point held vertically in position by an adjustable spring. The film of varnish is applied to the glass, and is passed under the stationary point, which is adjusted in such a way that it will scratch the surface. This gives valuable information as to the toughness as well as other features of the varnish.

The following tests by Mr. W. G. Scott may be added :--

The only absolute test for the durability of an exterior varnish is a practical weather test, and for interior architectural varnishes, a six months' test in a building under usual conditions.

Railway and carriage body varnishes are expected to retain a certain amount of lustre after an exposure of from twelve to fifteen months, and to protect the undercoats for a much longer period. Cheap agricultural implement varnishes are expected to show some lustre at the expiration of five to six months' exposure, and to protect the undercoat of paint for a year or more.

Furniture and other interior varnishes, while not exposed to the weather, are expected to withstand the effects of moisture, heat, etc., to a certain extent; conditions, however, vary so greatly that no fixed rule can be applied to them.

In addition to the durability or wearing quality, there are other points to be considered, such as ease of working, flowing, levelling, fulness, lustre, viscosity and body, time of drying, hardness and toughness, imperviousness to water, colour density, etc.

In varnish factories, where samples are to be matched and the quality determined quickly, a series of short tests are made to

ascertain the essential features and properties of the varnish in question. Nearly all varnish factories have, in addition to a chemical laboratory, a "testing department" where samples are matched for colour, body, working quality, time of drying, etc. Not only the samples received, but also every tank of varnish made, is subjected to such a test, and a report made; thus it is possible to match most of the samples from the material in tank. Cards prepared for the purpose are used for reporting these tests and are carefully filed for reference.

In the Testing department everything is compared with the "standard." The colour, body, drying and other features are tested with the standard, which may be a body, rubbing, baking, furniture or other grade of varnish.

Colour is generally determined first by comparison with the standard in small glass test tubes, the colour being reported as extra light, light, medium, dark or extra dark. The colour is again noted after the varnish has been applied and allowed to dry.

Body is determined by means of test tubes used for the colour test, the sample and standard being turned upside down, and the time noted for the rise of the air bubble.

Drying, glowing, levelling, and ease of working are features determined when the test boards are coated.

Experience has shown some very peculiar facts in connection with this test; for instance, whereas it is customary to make drying tests of japan driers on glass to determine their hardness, toughness, etc., this is not a proper method for varnish. Varnish must be applied on a surface to which it will adhere in order to determine its drying properties, hardness, etc. Natural wood properly filled, either with a silex wood filler or a good surfacer, and finished smooth, is the ideal foundation for a practical test of the working properties of a varnish. Oak, ash, maple, birch, mahogany, sycamore, and hard pine are the woods generally used for such test. Next to natural wood comes well-seasoned pine coated with primer, a surface obtained by means of "rough stuff" or similar material, and a final coat of flat colour applied. Manilla, or other strong papers, properly sized, oiled or treated with shellac, are also used, but are not looked upon with much favour.

It is obvious that the undercoats should be thoroughly dry before applying the varnish to be tested, otherwise the latter will sink into the undercoat and lose its lustre. The proper temperature of a varnish room, and the one at which drying tests should be made, is 70° F. Humidity is seldom taken into account, although it is an important factor and will sometimes be considered. Dry air currents hasten the drying of varnish.

The operator or tester, having his sample boards prepared, first pours a small quantity of the sample varnish into a clean cup, working it into his brush, and is almost sure at this point to note the odour, whether turpentine or benzine, or a mixture of the two. Some operators also claim to be able to distinguish the smell of wood oil, but this is rather difficult unless the material is an all wood oil varnish.

The sample varnish is now applied to the board and laid off in the regular way, crossing and recrossing. Usually four crosses are sufficient to determine the levelling property, but occasionally the work is crossed until the varnish 'sets up' (shows brush marks) in order to determine the limit of its flow. After being coated with the varnish the board is placed in a vertical position and allowed to dry. Runs and sags are noted, some judgment being required to decide whether such defects are due to the varnish or in part to the method of application. The time in which the varnish sets free from dust and the number of hours required for it to harden sufficiently to withstand the print of the finger are noted, the latter point being considered the drying time of the material. The determination of hardness and toughness can only be obtained by comparison with known standards, which are allowed to dry and harden for the same length of time. Some varnishes will harden to the verge of brittleness in three or four days, while others require months to reach the same degree of hardness.

Short-oil rubbing varnishes must not be compared with long-oil body goods, neither should furniture or hard-oil finishes (usually short in oil) be compared with exterior varnishes. The practical, or rather the professional, tester seldom makes a mistake in comparison, and it is really wonderful how close they can come to determining the relative hardness and toughness of the various

samples. After all the physical properties of the varnish have been noted and reported, the sample boards are subjected to a final weather test.

The following are reprinted from the authors' little work "The Painters' Pocket Book":—

To Tell if White Lead is Pure or "Reduced" with Barytes.

Put a little of the dry powder in a bottle (such as an oil sample bottle), add a little water and shake up; then add a little nitric acid (*aqua fortis*) and shake up well. If pure the white lead will all dissolve, but if there is any barytes it will be left undissolved.

To Distinguish Different White Pigments.

Put some of the dry powder in a bottle, cover with water and add a little hydrochloric acid (do not use the impure form known as spirits of salt, but get the pure acid from a chemist). Note what happens:—

1. If there is great effervescence, the liquid remains cloudy, and on standing beautiful crystals appear—the pigment is white lead.
2. If there is no effervescence but the results are otherwise the same—it is sublimed white lead.
3. If there is great effervescence and the pigment dissolves—the pigment is Paris white.
4. If there is no effervescence but the pigment dissolves—it is zinc oxide.
5. If there is no effervescence and liquid remains cloudy and smells of rotten eggs—it is lithopone.
6. If nothing at all happens—the pigment is barytes or China clay or silica.

To Test the Purity of Venetian Reds.

1. Put a little on an iron plate and heat nearly red-hot, then allow to cool; the pigment will go black on heating, but regains its

colour on cooling; any loss of brightness shows the colour has been "improved" by a dye.

2. Put some of the powder into each of two bottles; pour some boiling water over one and shake up well; allow to stand and pour the water off into the other bottle and shake up as before; clean out the first bottle and put a fresh lot of powder in it; pour off the water from the second on to this and so on until you have treated several lots of powder with the same water; then put a piece of blue litmus paper (which you can get from any chemist's) into this water– if it turns red the pigment contains acid and is unsuitable for paint.

To Distinguish Lakes from Mineral Pigments.

Place a little of the pigment on a piece of sheet iron and heat red-hot; lakes and organic pigments will be destroyed and burnt away, leaving a white ash; mineral pigments discolour or are unchanged with the exception of vermilion, which entirely evaporates.

To Test the Purity of Chromes and Brunswick Greens.

Shake up with hydrochloric acid (spirits of salt); this will dissolve the chromes but not any impurities such as barytes. In the case of Brunswick greens the Prussian blue will also be left undissolved—this may be removed by shaking up with solution of oxalic acid (salts of lemon).

How to Test Liquid Driers.

Take fifteen vessels and into the first put one measure of pure refined linseed oil, in the second, two, in the third, three, and so on up to fifteen, marking each vessel with the corresponding number. Then add to each vessel one measure of the drier to be tested and mix well with the oil. Note: Any little vessel, such as a thimble, will answer for measuring, but care must be taken to fill it up to the top each time, and also to drain away its contents. When the oil and driers are mixed take a clean fitch and paint out a small square with the contents of each vessel on a clean sheet of glass, taking care to paint each sample in the same manner and using a

fresh clean brush for each of the fifteen. The different squares should be arranged in a straight row and numbered to correspond with the vessels. The time each square is painted, and the temperature of the oil should also be noted.

Now clean out brushes and vessels thoroughly and repeat the operation, using this time white lead ground in oil instead of oil alone, but adding the drier to the oil as before. The quantity of white lead should be weighed in each case. Clean off again after painting the squares, and repeat all the operations with vandyke brown, and afterwards with lamp black. Now keep the painted sheet of glass under close observation, and note the time taken by each of the sixty samples to dry by touching them occasionally with the tip of the finger, at the same time note down anything of interest in the behaviour of each sample during drying. A comparison of the results given by each series will show clearly the influence of the drier on the oil, and if a parallel test is carried out in this manner with two different driers a clear idea can be obtained as to their relative drying powers.

To Compare two Samples of Pigment for Tint and Colour.

To ascertain that a new batch of colour matches perfectly it should be tested in the medium in which it is to be used.

1. Comparing the dry powders is sufficiently accurate for distemper and water-colour pigments. Place a little heap of the pigment on a sheet of glass or paper, and press firmly and evenly down with a palette knife to form a flat patch, then in the centre of this place a little of the standard pigment and press this again evenly with the palette knife so that the whole forms a continuous surface when any difference in tint is readily seen.

2. Comparing in oil. Take equal quantities of the two samples and mix each to exactly the same consistency in oil with the slab and palette knife. When thoroughly ground take a little of one paste on the palette knife, and spread out evenly on a sheet of glass, and spread the other in the same way so that the two patches almost join; then take a second piece of glass, place it on the first and press down until it causes the two paints to spread out and

just touch, when the minutest difference of tint can be observed even in two samples of a white pigment such as white lead.

Red Lead—to Test the Purity of.

1. Take a very small quantity of the pigment, place in a bottle, add nitric acid (*aqua fortis*) diluted with its own bulk of water, and heat nearly to boiling point by standing in a pan of briskly boiling water for some time; the red lead will change to dark brown in colour; now add a little sugar, when if pure it will entirely dissolve—if a red sediment remains it indicates adulteration with iron oxide or brick dust.

2. Put some of the powder in a bottle with methylated spirit and warm up in the same way; the liquid should remain quite colourless—if it turns red it indicates adulteration with vermilionette.

Turpentine Substitutes—to Test the Quality of.

Turpentine substitutes are, as a rule, volatile oils obtained by distillation of petroleum. To be satisfactory for painting they should be free from non-volatile oil on the one hand, and highly volatile spirit on the other. Take a sheet of clean white paper and place on it side by side a drop of substitute and a drop of genuine American turpentine, taking care that each drop is as nearly as possible equal; wave the paper in the air and carefully watch the drying out of the spots—if the substitute does not dry out completely, and at about the same rate as the turpentine, it is inferior.

Another useful test is to put some of the substitute in an ordinary white plate or saucer which just fits over the top of a saucepan or can. Half fill the can with water and keep this boiling on the stove until the spirit is quite evaporated, when the plate should be quite dry, or, at most, only show the faintest suspicion of greasiness.

To Test the Permanence of a Pigment.

This can only be done by actual exposure to light for a prolonged period; there is no satisfactory method of deciding the point

quickly. A good way of performing the test is to grind different samples of the pigment in pure linseed oil and gum-water respectively, spread a little of each paint on a sheet of glass, press another sheet of glass on the top so that it spreads the paint into a thin film, and bind round the edges with gum paper or place in a frame. Prepare another sheet in exactly the same manner. Now place one of these prepared samples away in a drawer, and the other out of doors where it can get plenty of sunlight, and examine and compare at intervals for six months.

TURPENTINE—TO TEST THE QUALITY OF.

1. Place a drop on a piece of clean white paper; the spot made should entirely disappear on allowing it to dry- any greasy mark remaining shows that the turpentine is not properly refined or is adulterated.

2. A floating hydrometer (which can be purchased for a shilling or so) is useful for testing the specific gravity of turpentine. The instrument is simply floated in the spirit, and the mark on the scale read off where it emerges from the surface; this should read ·867 if pure.

3. Flash point. Pour a quantity into a small dish or any shallow vessel, then pass a lighted match over the surface without allowing it actually to touch the surface. If the vapour takes fire, the flash point is below the temperature of the room in which the experiment is done, and the spirit most probably contains light naphtha or benzine. If the vapour does not fire under these conditions, pour into a small saucepan (the smallest size of enamelled saucepan does very well) to the depth of about one and a half inches. Connect a tin mouth blowpipe (or any other tube ending in a small orifice) to the gas supply by means of rubber tubing, turn on the gas, light it at the nozzle of the blowpipe, and then turn down the gas until the flame is about half an inch long. Put the blowpipe in a position convenient for the right hand. Hold the saucepan in a large vessel filled with water at 60° F. and stir with a thermometer. The temperature will gradually rise. At each five degrees rise, *i.e.*, when the thermometer indicates 70°, 75°, 80°, 85°, 90°, 95°, 100°, transfer

the thermometer to the left hand, which also holds the handle of the saucepan, and bring the small flame on the blowpipe over the surface without touching it. Repeat this at each of the temperatures given until the vapour catches fire and a blue flame runs over the surface of the liquid. The temperature shown by the thermometer when this occurs is the flash point.

To Distinguish between Different Red Lakes.

The more permanent alizarine and Para reds may be distinguished from the less durable vermilionettes and cochineal lakes by boiling small samples successively in water, methylated spirit, and caustic soda, allowing to settle and noting the coloration given to the liquid, as shown in the following table:—

	Water.	Spirit.	Caustic Soda
Cochineal lake	None	Bright red.	Deep crimson red.
Vermilionette and rosin lakes	Deep red.	Red with bloom.	Red with bloom.
Para reds	Orange	Orange red	Bluish red.
Alizarine reds	None	None.	Violet.

Fast Reds.

As explained elsewhere, the body of these reds is, as a rule excellent, but if doubt exists, the test may be made of painting out one coat on a primed board. The red ought to cover well with a single coat. The most important quality to ascertain is whether the red will bleed or not, *i.e.*, whether it will find its way through any paint which may afterwards be applied to it, such as, for instance, when it is desired to change the colour of a wall. The test is a simple one, namely to place some of the red in oil with a little turpentine in a bottle, to shake it up and then allow to settle; if the oil is tinted red it indicates that the fast red is soluble, and therefore that it will bleed, but if the oil remains uncoloured, then the fast red will not

bleed. As this class of paint is mostly supplied with a guarantee as to its non-bleeding qualities, it is more frequently necessary to ascertain whether the red colour used on a wall will bleed if painted a different colour. The simplest way to ascertain this is to scrape off a little of the red paint—choosing, of course, some inconspicuous part of the wall—to powder this and place it in a bottle with oil and turpentine as before, when the same results and conclusions may be looked for and drawn as before. Another method is to mix a little white lead or zinc oxide with ordinary salad oil, which means, of course, it will not dry, and to place a little of this on the red surface and leave it for twenty-four hours. If the red will bleed, the white will be tinted, but not otherwise.

White Enamel.

The simplest method of testing enamels is to paint out samples on primed and painted boards and expose them to the weather, noting their condition at intervals of say every two months. As explained elsewhere, it is important that the undercoats receive the very closest attention, as unless these are more or less perfect, the enamel will not stand. There are, however, other tests which may be applied. The colour of white enamel should tint toward very slight blue, that is to say, it should not have a yellowish cast. Of course, broken whites may be obtained, *i.e.*, those to which a very small quantity of tinting colour has been added. By comparing one enamel with another, the colour can be easily determined, or it may be compared with an oil paint, such as zinc oxide, which may be taken as a standard white.

Some enamels have much better body than others, but speaking generally those which are best in body are most difficult of application. A first-class enamel should be comparatively easy to apply, and flow out well, that is to say that the brush marks should disappear immediately after the enamel is applied. If the enamel is applied to a sheet of glass this property can be readily ascertained. The length of time required for an enamel to dry dust-proof varies considerably, but very quick-drying enamels may be regarded as less durable than those that take twenty-four hours.

Plaster.

It is sometimes desired to ascertain whether a newly plastered wall is sufficiently dry to receive paint. A very simple method of doing this is to take a small piece of thin gelatine such as is used for Christmas crackers. This should be held against the wall by means of a stick applied to the centre. If it remains flat the wall is probably all right, but if it curls away the surface is too damp for painting.

To ascertain whether there is any free caustic lime in the wall, take two pieces of red litmus paper, which may be obtained from any chemist, wet them in water, place one on the wall and the other on a piece of glass. Leave the one on the wall for a few hours, and then compare the two. If the sample on the wall has turned blue, even to a small extent, there is free alkali present, and the surface is unfit to receive oil paint.

CHAPTER IV

THE PAINT MOST SUITABLE FOR DIFFERENT SURFACES

It is now desirable to consider the different paint mixtures which are best adapted for preserving the surfaces to which they are applied. It need hardly be said that the composition will vary very considerably both as regards pigment and thinner. For example, in painting on absorbent plaster much more oil and turpentine will be required than when painting on iron or steel, which are comparatively non-absorbent, although cast iron is much more absorbent than steel. The pigments most suitable will also vary with the surface, as, for example, red lead, iron oxide and graphite, which are so useful when used as protectors of iron, will only rarely be suitable for application to wood and plaster.

The subject may be divided up under heads as follows:—

(*a*) Outside work exposed to the action of the elements.

(*b*) Inside work not so exposed. These may be sub-divided according to the material or nature of the surface to be painted as follows:—

1. Ordinary pine or deal.
2. Hardwoods.
3. Portland and other cements
4. Stucco.
5. Ordinary plaster.
6. Patent plaster.
7. Iron.
8. Steel.
9. Copper.
10. Galvanised iron.
11. Zinc.
12. Boats or situations exposed to conditions alternately wet and dry.
13. Lead.
14. Canvas.
15. Steam pipes and radiators.
16. Ships.
17. Carts and barrows.
18. Machinery.
19. Breweries.
20. Floors.

21. Pine, natural finish of.
22. Brickwork.
23. Blackboards.
24. Teak.
25. Workshops and factories.
26. Pitch Pine.
27. Gasometers.
28. Chemical works.
29. Seaside.

Some of these surfaces would usually be limited to inside work, as, for example, plaster, while on the other hand, the use of stucco, Portland cement, would usually be restricted to outside work. The nature and proportions of the various ingredients which make up a paint have been described in Chapter II. It remains now to enquire which of these should be used on the various surfaces named and in what proportions. Of whatever the paint is composed there are three important essentials if good results are to be obtained. The first is fineness of pigment—a coarsely ground paint is rarely durable; secondly, perfect amalgamation of the several parts—in other words, a thorough mixing; and thirdly, such a perfect straining through a fine-meshed wire that all dry particles of paint usually known as "nibs" are strained off.

Deal or Pine (Outside).—For many years past pure white lead mixed with pure linseed oil, American turpentine and patent or paste driers have been regarded as the constituents of the best possible paint from the point of view of providing a protective coating. This opinion is still held by many decorators, architects and property owners, although, as a matter of fact, there is abundant evidence to prove that, at least, other white pigments or a mixture of them may be substituted either partially or wholly for the white lead.

As already pointed out, white lead has the advantage of possessing excellent body and working smoothly under the brush; but on the other hand it has two very serious drawbacks, the first being that it is poisonous, and second, that it is susceptible to impure air, sulphur, etc., which causes it to darken and lose its durability.

Many paints contain no white lead whatever; for example, graphite, ochres, siennas, greens, Venetian and Indian reds, and many others might be named which are much used and prove quite durable. So far as whites are concerned the zinc paints, principally

zinc oxide (not lithopone), are extensively used without the addition of white lead. Before, however, these are considered it will be convenient to explain the usual mixture adopted by practical painters. When white lead is used the composition of the priming or first coat may be as follows (the figures give the quantity required for painting 1,000 square yards): –

First Coat.

250 lbs. of white lead.
16 lbs. of paste driers.
12 gallons linseed oil.
2 gallons of turpentine.

Second Coat.

167 lbs. white lead.
10 lbs. 7 ozs. paste driers.
2½ gallons linseed oil.
2½ gallons turpentine.

Third Coat.

167 lbs. white lead.
15 lbs. 1 oz. paste driers.
5¼ gallons linseed oil.
1¼ gallons turpentine.

For smaller surfaces these figures can, of course, be divided up. The reader on a careful examination of them will observe, first, the large amount of oil used on the priming coat. This is added because the wood, of course, on the first coat is very absorbent. On the second coat it will be observed that much less oil is used than on the last coat. This is done in order to provide a comparatively flat surface; and it should here be observed in all painting work consisting of several coats the rule should never be departed from of making the coats alternately sharp and oily. By "sharp" is meant a paint which dries almost without gloss, hence but comparatively little oil

is given and plenty of turpentine, and in the coat which follows much more oil is used. It is found in actual practice that this plan causes the various coats to adhere one to the other in the most satisfactory manner.

Most painters in this country, at least, add a little red lead to their priming coat, although the practice is by no means universal. The usual proportion of red lead is from half an ounce to one ounce to every pound of white lead. This, however, may be varied according to circumstances. The idea in using red lead is to produce a hard undercoat. Before the priming coat is applied it is necessary to rub down the work with glass-paper to remove any dust or dirt which may adhere to it. Before the priming coat the process of knotting is gone through. This consists in applying one or two coats of shellac dissolved in methylated spirits, usually known as "patent knotting," to the knots with the object of preventing any rosin which might exude from finding its way through the paint and spoiling the colour.

It should here be observed that there are many grades of shellac varnish or patent knotting on the market which are grossly adulterated with rosin, which is most objectionable in paint work, and as in other painters' materials, care should be taken to purchase only the best quality. Where the knots are very large they should be cut out and the hole filled with wood plugs securely glued in position. The knotting should be put on very thinly, and two coats should always be given, the second one being a little beyond the actual knot itself. Washable water paint mixed with a little red lead can be used for knotting. Another excellent method is to cut out the knots and fill in the holes with alabastine mixed very thick and smooth level the surface. This will not crack or shrink and may be relied upon. When the very best work is required gold or silver leaf is sometimes employed. This is particularly the case with work under high-class enamel.

Having given the method of painting white lead we may now consider the alternative methods. These may be divided under two heads:—

1. Using different pigments in various coats.
2. Using a mixture of pigments.

As to the first it should be very carefully considered that it is not necessary to use the same paint throughout, and in the opinion of the writer it is ridiculous to do so, although it is a general custom. It surely stands to reason that the final coat is the one which resists the action of the weather, and those underneath do not require to be the same composition simply because they are not exposed. At the same time it is, of course, necessary to see that the pigments used do not adversely affect each other, and also that the condition of alternate sharp and round coats already referred to is strictly followed.

For cheap work the first coat after the priming may be a washable water paint, and upon this can be used lithopone, with a final coat of zinc oxide to which has been added a little white copal varnish. This will make a thoroughly durable job and is very suitable for cottage work. Of course, the zinc oxide may be tinted to any colour desired, just exactly in the same way as white lead, with the additional advantage that the paint will be purer because the white of zinc oxide is whiter than lead. For a better job the first coat might be lithopone and on this two or three coats of zinc oxide, the final one being mixed as before with a little really good hard copal varnish. For higher class work the writer recommends zinc oxide throughout. The varnish, if mixed properly and not in excess (which is likely to cause the paint to "set up" or become unduly stiff), will be found to greatly increase the durability. Here again any colour desired may be added.

Coming now to the consideration of a mixture of pigments, it has been proved by a very large number of experiments, very carefully conducted in America, that a mixture of pigments ground together (not mixed in the painter's can) gives a far more durable paint than any single pigment used by itself. Perhaps the most striking example of this is in grinding white lead and zinc oxide together. Equal quantities of each or two-thirds of lead and one-third of zinc oxide gives a really splendid paint which will last far longer than either zinc oxide used by itself or lead used alone. The reason is that one pigment corrects the shortcomings of the other; thus, white lead is apt to "chalk" particularly when used on the sea shore. Zinc oxide under certain conditions will become very hard

and brittle. Here, then, is an instance where one pigment helps the other. Sometimes a little asbestine, which is a light form of asbestos, is added in a small proportion, and sometimes also a small quantity of an inert material, such as sulphate of barium, is also added. From 5 per cent. to 10 per cent., can be used with safety. In the case of these paint mixtures they can be used throughout, or for the final coat only, as may be desired.

Inside Work. Woodwork on the inside is quite frequently painted in exactly the same manner as that which is exposed to the weather, excepting that raw oil is substituted for boiled. In the writer's opinion, however, lithopone, which is so much cheaper than white lead, would give the same or even better results. The use of lithopone has also the advantage, as already pointed out, of being non-poisonous. The economy effected by its use is, at least, 25 per cent. or even more on the cost of material. Here again the paint may be tinted to any desired colour. In bedchambers the custom is to finish in what is termed "bastard flat," that is to say, an egg-shell gloss which gives a very pretty effect. The custom of tinting the woodwork to accord with the prevailing colours in the wall paper has practically died out and nowadays white is employed to a very large extent, the cheapest form in the end being white enamelling, which is referred to on another page. Graining has to a great extent gone out of fashion, but bids fair to again become popular, its remarkable durability having rendered it very serviceable for certain positions, such as kitchens, etc.

The question has often been asked the writer whether lithopone, such as Charlton white, when used inside, will be found really durable. The answer is emphatically "Yes." The paint properly mixed will last quite as long as white lead.

Hardwoods.—Hardwoods such as oak are sometimes painted both when used inside and outside, but unless the wood is of inferior quality, it is a great pity not to bring out the beautiful grain which many varieties possess. The same is true with other hardwoods. As a rule, it will be found necessary to stain the wood. This may be done in several ways by using a water stain, a spirit stain, or mixing a stain with the varnish. In either case it will be found necessary

to fill the pores of the wood. This is done by means of what is known as a "filler," which is supplied in paste form by the varnish and paint manufacturers, and is thinned down to the required consistency by adding turpentine. It is brushed on very vigorously, with a rough brush so as to force the filler into the open pores of the wood. After a little time, the superfluous filler is scraped and wiped off, the surface is glass-papered and the stain and varnish can then be applied. If there is any portion of the work which is sappy, it is well as a matter of precaution to give it a coat of light shellac varnish. A good outside oak varnish will last on this work for some considerable time.

When used inside, oak is sometimes polished by hand in the same way as mahogany is polished by a French polisher, but if desired, varnish may be employed on inside work also. Recipes for stains are not given here, as it will be found in practice that they can be purchased ready for use much cheaper than they can be made by the painter. Mahogany, walnut, and bird's-eye maple should always be French polished and not varnished, as the effect is very much superior. In dealing with tops of tables, cheffoniers, etc., which are likely to become marked by glasses containing wine or spirits placed upon them, it is desirable to use a special varnish made for the purpose. This is a rubbing varnish of good quality, and properly applied, it will not mark at all.

Oak.—Oak is frequently fumed, that is, darkened by exposing it to the action of strong ammonia fumes. This necessitates the use of a temporary box or very small room, in which the article to be fumed is placed. Those who have much fuming to do have a special box prepared for the purpose. The ammonia is placed in open saucers, the box is made perfectly air-tight, when the fumes attack the acid contained in the wood and cause it to become much darker. The longer the wood is left in the box the darker it becomes. In order to judge as to whether the desired colour has been produced it is usual to bore a hole through the box, to place in it a peg of the same oak as that being treated, making it longer than the thickness of the wood through which it passes. By withdrawing this peg from time to time the depth of colour can be judged by the portion of it which was exposed inside the chamber. Sometimes a small

window is made in the box by which to view the fumed articles from time to time.

Boiled linseed oil is often used on oak, mahogany, etc., and it considerably enhances the beauty of the grain. Two or even three coats may be given, allowing sufficient time for each coat to become quite hard, and a very little liquid drier or gold size may be added if it is desired to hasten the drying. Wood thus treated may be varnished on top of the oil, if desired, when it will be found that one or two coats will be sufficient. If the wood is of a light variety it may be deepened in colour by the application of a suitable stain. If the oak or other hardwood is of poor quality it is advisable to give it a coat of patent knotting or shellac varnish before applying the oil, so as to prevent suction and a consequent darkening of the parts.

Portland Cement.—Portland cement when used outside cannot successfully be painted upon with oil paint until it has been exposed to the weather for at least six months—twelve months is safer, but there is a method by which the oil painting may be proceeded with immediately, which is, by giving the fresh Portland cement two coats of sulphate of zinc (white vitriol) dissolved in equal weight of water. This method was discovered by Mr. McNichol, of Washington, D.C. It has been largely used and is almost invariably successful. After a couple of days of the application of the second coat, oil paint may be used freely. Another method sometimes used is to apply two coats of alabastine.

As to the paint which is best adapted for Portland cement a great deal of difference of opinion exists, but those well versed in the subject believe that a mixture of 70 per cent. of white lead, 30 per cent. zinc oxide, ground together in about 80 per cent. of raw linseed oil and 20 per cent. of turpentine will yield a paint which is very well adapted for the purpose. In the last coat there should be 90 per cent. of raw linseed oil and 10 per cent. only of turpentine, and it is well to add one pint of good copal mixing varnish to each gallon of paint. In the actual application the paint should be well worked into the surface and each coat should be thoroughly dry before the application of another. Red lead is often added to the priming coat and plenty of thinners are used owing to the absorbent nature of the surface.

In making repairs on exterior work with Portland cement it is well to remember that new cement must be kept quite wet during the time it is setting. The author once had some repairs done in this cement on a number of houses situated in a street which was built due west and east. The work was done in the heat of summer and it was found that on those houses facing south the cement crumbled away under the touch, while on the opposite side facing north the cement was in excellent condition. The explanation was that the moisture was drawn out by the hot sun before the cement had time to set.

There are now on the market special paints prepared for Portland cement, one of the active ingredients being Chinese wood oil (*q.v.*) mixed in proper proportions.

Stucco.—This is a term applied to any ordinary plaster or cement which is used to form the external surface of a building; hence Portland cement, which is sometimes used for this purpose, comes under the head.

The treatment of individual stucco work will depend upon the composition of which it is made, and this is not always easy to ascertain. If it is Portland cement, it may be painted upon shortly after it is set by applying a coat of sulphate of zinc or white vitriol, as explained under the head of "Portland Cement." If, however, it is of a different composition, the method usually followed is to use boiled oil with a little red lead in the first coat only, and to follow on with a paint of ordinary composition. It is the first coat that it is necessary to take great care with, and if this is satisfactory, the remainder of the paint may be practically that used on woodwork. For the first coat about 3½ lbs. of red lead will be required to every 1 cwt. of white lead. Many stucco buildings are found in London and other large cities, and these should have a finishing coat of zinc oxide so as to prevent change of colour by the sulphur contained in the atmosphere. The usual plan is to finish such buildings stone colour by mixing French yellow ochre and a little umber to white lead, or umber may be used without the ochre if desired. It is curious to note how frequently painters complain of stucco houses which are repainted with white lead changing colour, and various reasons are assigned, such as impure oil, bad turpentine,

etc. A case came before the author recently in which a row of houses was painted, finished with white lead in the manner described. One of them became much discoloured after a few weeks, and the decorator was greatly puzzled as to the reason. It might be mentioned that the houses were painted in November, about the worst time in the year for painting operations in general, especially on outside work. Doubtless the explanation was, that a chimney was in close proximity to the house in question, and that the smoke containing sulphur was blown down during the bad weather on that particular house, and that the sulphur contained attacked the white lead and caused the darkening alluded to. If zinc oxide is used for a final coat, and a little good varnish is mixed with it, there is no risk whatever of any change of colour. Even a better method is to finish in zinc oxide and then give a good coat of hard outside varnish. Although the expense is considerably added to, yet the durability will be found to fully justify it.

Plaster.—The painting of plaster inside is not difficult if a good foundation can be provided. In old plaster work, there is often a good deal of patching, sometimes with different kinds of cement or plaster, and the result is that it is difficult to give a uniform finish. A coat of sulphate of zinc, however, will form a good ground, and three coats of oil colour may be applied over this when dry.

If the plaster is new, and is to be distempered, it should have a coat of sulphate of zinc followed by a coat of oil paint mixed with very little turpentine, but plenty of oil. When this is dry, it forms an admirable foundation upon which it is easy to brush distemper. When washable water paints or washable distempers are used, the same plan is followed, but sometimes it is necessary to size the walls if they are porous before applying the paint. Special sizes are made for the purpose

Patent Plaster.—Several of the patent plasters, such as sirapite, adamant, etc., require a special treatment for painting. If they are left like ordinary plasters for a week or so before the paint or distemper is applied, it will be found that the surface has become quite hard and smooth, being in fact, almost like a sheet of glass and giving no key whatever to any paint or distemper that may be

brushed upon it. The only successful way—and it is a simple one—to deal with these plasters or cements, is to apply a coat of sharp colour, *i.e.*, one mixed with very little oil, plenty of turpentine, and a little gold size; but it is of the utmost importance that this be applied to the plaster before it is set hard, indeed *just as soon as the plaster is sufficiently firm to withstand the pressure of the brush.* It will dry as the plaster hardens, and form part of it, and it will give a key or grip to any paint or distemper which may afterwards be applied. It will be understood that it will be useless to apply the sharp colour several days, say a week, after the plaster has been put on. Should such a case have to be dealt with the only way is to roughen the surface of the plaster by means of coarse glass-paper.

Iron.—A great difference of opinion exists as to the best paint for iron, and for many years a controversy has been carried on between engineers, architects and painters on this subject, one set of men claiming that red lead is the only satisfactory paint for iron, others being equally positive in favour of oxide of iron, while still others claim that graphite is the all-important paint for this purpose. The writer has great faith in both red lead and iron oxide, but when the iron is of an important character he would prefer to use one of the special paints for application to iron that are on the market. These are all composition paints, specially designed for the purpose, and although they cost a little more than the red lead or the iron oxide they are well worth the additional expenditure.

The first thing to be done in painting iron is to see that it is dry, and that all mill scale is removed, otherwise this is likely to detach itself later on, carrying the paint with it. It is absolutely essential to get a good job that all rust be removed, because it has been found in practical experience that if paint be applied over rust the oxidation will continue underneath the paint film. It is of very great advantage if the ironwork has a coat of boiled oil or of red lead paint before it leaves the foundry, but where this cannot be done it is a great mistake to let the iron rust before painting as is customary. To clean the iron wire brushes are used in conjunction with scrapers or even rough chisels. These wire brushes are made in various forms, as shown in the illustration (p. 143), and some are like large tooth-brushes, very useful for dealing with the smaller parts, while the

larger brushes greatly facilitate the removal of the rust from large surfaces.

The very best way to clean iron is to use a sandblast, by which means it can be reduced to the state of polished silver, and if the paint is applied to this it will adhere and prove exceedingly durable. Four coats should be given, the first mixed with red or orange lead, which gives a good foundation, and the final coat should be a varnish paint. Messrs. Cushman and Gardner in a valuable book on the "Corrosion of Iron" give a number of recipes for paints for application to iron from which we extract the following:—

White Paint.

	(By weight.)
White lead	67 per cent.
Zinc oxide	20 „
Asbestine	3 „
Calcium carbonate	10 „

Chocolate Colour.

Metallic brown, neutral	90 „
Willow charcoal	5 „
Zinc chromate	5 „

Red.

Bright red oxide free from acid or sulphur	95 „
Zinc chromate	5 „

Another Red.

Bright red oxide	65 „
China clay	15 „
Red lead	15 „
Zinc chromate	5 „

Black.

Willow charcoal and bone black	68 „
Zinc chromate	2 „
Inert pigment	30 „

Greens.

	(By weight.)
Zinc oxide	45 per cent.
Sublimed white lead	25 „
Inert pigment	15 „
Zinc chromate	5 „
Prussian blue	5 „
Medium chrome yellow	5 „

White.

Zinc oxide	60 „
Corroded or sublimed white lead	30 „
Asbestos	10 „

Wire Fence Paint.

Natural bright iron oxide	65 „
Silica	20 „
Red lead	5 „
Willow charcoal	5 „
Zinc chromate	5 „

Referring to the last-mentioned Messrs. Cushman and Gardner say: "Ground in oil alone this paint would afford a good protection to wire, but when ground in a vehicle of the following nature it would prove of even more value: boiled linseed oil. 23 per cent.; raw linseed oil, 45 per cent.; Kauri varnish, 20 per cent.; turpentine drier, 12 per cent."

It will be observed that red lead is used in these recipes very sparingly, and also that zinc oxide and notably zinc chromate are favourites for use on iron.

In repainting iron the same process as that described is followed, wire brushes being employed as before. Unless the work is in a very bad condition it will not be necessary to give it a coat of red lead, but ordinary paint mixed with hard varnish will produce a satisfactory result. It may be mentioned that sometimes the use of red lead is objected to by reason of the fact that it sets so quickly in the painter's pot. In such a case, orange lead, which is a very similar pigment, may be used instead.

In preparing the paintwork on iron bridges and other parts of railways, etc., it is often found necessary to use special tools worked by electricity. These may be described as consisting of a chisel and hammer combined, and by their use rapid taps are made and the loose scale quickly detached.

Mr. J. Cruickshank Smith, B.Sc., F.C.S., in a paper read before the Paint and Varnish Society on the "Protection of Constructional Iron and Steel," gave the following fundamental axioms in connection with the preparation and application of protective paints for iron and steel:—

"As to the paint—(1) The particles of the pigment should be reduced to the smallest possible size, and should be packed as closely as possible in the paint film.

"(2) There should be absolute perfection in the incorporation of the vehicle with the pigment.

"(3) The pigment and the vehicle should be properly proportioned, it being always borne in mind that the pigment is the real protective (*i.e.*, moisture-resisting) agent, while the vehicle binds the pigment and enables it to be spread uniformly over the surface.

"(4) The proportion of volatile constituents should be reduced to a minimum.

"(5) Moisture should be absent from the paint, as also should materials capable of yielding water as a product of partial decomposition.

"(6) Acid and materials capable of giving rise to acid should be absent.

"(7) The first, or priming coat, is of great importance and should partake of the nature of a 'filler.' In this coat the pigment and the vehicle should be most carefully selected and proportioned, as on it much of the efficiency of the succeeding coats depends.

"As to the surface—(1) The surface should be perfectly clean and free from moisture, rust, mill-scale and grease.

"(2) Not only should all ordinary surfaces be painted, but special attention should be given to bolts, rivets, nuts, ends of plates and girders, and all flanges or angles which have to be bolted together in order that the paint may form an insulating coating. The condition of 'metal-to-metal' will certainly induce corrosion.

"As to the film—(1) The drying of the film should proceed uniformly throughout its whole depth.

"(2) Change in volume during and after drying should be reduced to a minimum.

"(3) The film will form an efficient protector in strict relation to the time during which it is impervious to moisture."

Dr. J. Newton Friend, who has closely investigated the subject of painting iron and steel, gave the two following important facts as a result:—

(1) The surface of a paint film on iron or steel does not always give a correct idea of the extent of the corrosion beneath.

(2) The addition of a small quantity of paraffin wax to linseed oil greatly enhances its protection factor.

Bituminous paints have much to recommend them for the protection of iron, provided that they do not lose their elasticity and gloss on exposure. The author has examined many different exposure tests made with various special paints on iron, and has found that only about one-third of them stand for any length of time. There is an opportunity here for the engineer, architect, etc., to make tests for himself. Small pieces of sheet iron, say 6 inches by 4 inches can easily be obtained, and these, painted, are exposed, say, outside his office window. Each paint should be applied with a different clean brush or fitch. A record should be made by examining the different specimens periodically.

Iron, Special Paints for.

The following brief list of special paints intended for application to iron, to aid in its preservation, is not meant to be exhaustive. There are doubtless many other special materials which might be strongly recommended. Those mentioned below the author is more or less well acquainted with, and they can be recommended as good paints of their respective kinds.

Grisol.—Experiments conducted by the author show that this is an excellent paint when used as a rust preventative for iron, steel, etc. It is non-poisonous, and very durable. It is easily flowed on and dries with a hard, firm coat. For many purposes it takes the

place of red lead paint, and the cost per hundred square yards works out at from 5*s*. 5*d*. to 5*s*. 8*d*., as against 8*s*. 1*d*. to 8*s*. 3*d*. for red lead. When used on ironwork, galvanised iron, etc., it is necessary to thin with turpentine to the required consistency.

Silica-Graphite Paint.—This paint has been used successfully on many important buildings, some of them, such as Charing Cross Station Roof, Cannon Street Station Roof, being very trying to the life of any paint. It is supplied in the natural colour, a dark grey, but may be had also in black, suitable for steel, smoke-stacks, border fronts, ornamental ironwork, and surfaces subjected to sulphurous fumes. It is also made in olive green and dark red. In cases where it is desired to finish with a light colour, a light paint may be applied over the silica graphite paint.

Black Composition.—This is a substitute of Brunswick black, which resists heat and gives a good surface. It costs only 1*s*. 3*d*. per gallon, and is only suitable for cheap work.

Ferrubron Paint.—This is non-poisonous, made on a base of steel-grey metallic powder. It covers well, and is economical in use.

Ferrodor Paint.—Ferrodor paint is unaffected by salt spray or ordinary chemical or atmospheric conditions, and has been largely used, therefore, for painting bridges and ironwork on the seashore and in other positions. It has been employed in many parts of the world with considerable success, and may be said to be suitable for bridges, structures of iron or steel, gasworks, piers and harbours, roofs, shipworks, etc. For the last-named purpose it has been used by the North German Lloyd Co. for some time past. The natural colour of the paint is dark steel grey, having a brilliant metallic effect. The elasticity of the paint itself when dry is readily demonstrated by coating a sheet of zinc with Ferrodor paint, and then dissolving the zinc in a bath of sulphuric acid solution, which leaves the film of paint by itself. This paint is made in a variety of pleasing colours.

The foregoing relates to "Ferrodor paint." Under the name "Ferrodor," the natural metallic powder is supplied, which contains about 95 per cent. of rustless peroxide of iron. It may, therefore, be employed with safety as the best paint to be used upon iron and steel structures of all kinds. Intense heat or cold has no effect

upon it, neither has salt, soft, hard, or distilled water. It also withstands acids, alkalies, etc.

Brigg's Bituminous Enamels and Solutions.—There is much to be said in favour of these paints applied to iron, which are made on a base of bitumen. If the medium is a good one they are found to last a considerable time. The above solution has been used on many important works, including the celebrated Forth Bridge.

Steel. Mr. J. W. Laurie, in a paper read by him before the Eighth International Congress of Applied Chemistry, gave the result of some interesting experiments he made with a view of ascertaining the durability of different paints when applied to steel. Without mentioning the details of these tests, it may be stated that the five paints which proved themselves most durable were, in the order named :—

1. Red chromate of lead.
2. Sublimed lead.
3. Red lead } Equal.
4. Zinc chromate } Equal.
5. Corroded white lead, showed up very badly.

Copper.—This may be painted by using a coat of good water paint as a priming coat, but oil paint should never be applied to the metal direct. Sometimes the surface of the copper is roughened to give a key. When it is desired to give copper an antique appearance, such, for example, as when it is used on a roof which is exposed to view, or for flashings in bay windows and balconies, a solution of citric acid or oxalic acid should be given. This will be found to be effective and to produce an oxidising effect fairly quickly. Another method is to use one part per weight of sal ammoniac, three parts per weight of tartaric acid, nine parts of common salt dissolved in fifteen parts of boiling water, to which solution while still hot eight parts by weight of solution of copper nitrate are added.

Galvanized Iron.—Ordinary corrugated iron, so largely used for temporary churches, school-rooms, sheds and workshops, is, of course, covered with the metal zinc which is applied by merely dipping the iron sheet into the molten metal. This zinc fully

protects the iron beneath from oxidisation, and should last at least two years or even longer. If, however, it becomes partially detached it is often necessary to apply paint, and this is first, often a big undertaking where there is a large quantity to be done. The plan often followed is to use the paint contained in what the painters call the "smudge pot," which means all the waste paint left over from various jobs ground together. This, however, is not desirable, because the labour involved justifies the use of a much better paint. The author has found that the best means of dealing with a case like that mentioned is to apply a good round coat of first-class washable water paint, and when this is dry to paint upon it oil paint in the ordinary way. The distemper adheres closely to the zinc, and forms an excellent undercoat for the oil paint.

A good mordant or primer under oil paint for galvanized iron is to apply a solution of two ounces each of copper chloride, copper nitrate and sal ammoniac, dissolved in one gallon of water in a glass or earthenware vessel (not metal) and to add two ounces of hydrochloric acid.

Under the head of "Special Paints" will be found descriptions of several mixtures patented and otherwise which are prepared for application to galvanized iron.

Zinc.—Although some painters think it sufficient to roughen the surface of metal zinc before it is to be painted by means of glass paper, and then give a coat of water paint as a primer, a much better plan is to use the following mixture:—Dissolve equal parts of nitrate of copper, sal ammoniac and commercial hydrochloric acid in water; brush this fluid over the zinc and after twenty-four hours it will be found to be dry and will take paint.

Another method is as follows:—Into some hydrochloric acid of full strength, drop small pieces of zinc, which will be found to effervesce. When the effervescence ceases, add an equal quantity of water, and with a sponge tied to a stick wash over every part of the surface to be painted. This will take off grease, and when dry it may be painted upon with safety.

Boats.—There are various special paints made for boats and yachts The best the author has come across is made from a mixture of zinc oxide and white lead in the proportions of about one-third

of the former to two-thirds of the latter, these being ground together in oil in a proper paint mill, and afterwards carefully strained. This paint is improved if a little varnish, which will resist the action of water, is added. Paint made in this way will withstand the action of alternate wet and dry conditions very well indeed. In a series of tests conducted some twenty-five years since the paint mentioned was proved to be more suitable and more durable than any other.

Surfaces. In repainting a boat it is first necessary to either remove the whole of the old paint in cases where it is blistered or much discoloured, or to rub down to a smooth surface with pumice stone and water if in a fair condition. This is best done by using one of the paint removers referred to elsewhere.

Lead. -This metal is very rarely painted, but occasionally from a decorative point of view it becomes necessary. Provided that the lead is clean and free from grease it may be painted upon in the ordinary manner, excepting that the first or priming coat will, of course, not require so much oil as if it were applied to more absorbent wood.

Canvas.—It is sometimes necessary to paint canvas, as, for example, when it is stretched over a frame to form a partition, although nowadays compo board or its equivalent is more frequently used for that purpose. In painting canvas it is necessary to give two coats of size to which has been added a small quantity of alum. When this is dry ordinary paint is used with very little driers in first coat, and great care must be taken that the paint is not too thin, and that it is well rubbed into the interstices of the canvas. The remaining coats may be applied in the same manner as to wood, and of course any colour desired may be added.

Steam Pipes and Radiators.—In order to resist the heat of steam, etc., steam pipes and radiators cannot be painted with ordinary oil paint, as it would be soon destroyed. Aluminium paint, which dries with a silver-like finish and does not tarnish, should be used, but care must be taken to select the variety which is specially made to resist a high heat. The underneath coats may be white lead mixed with baking Japan and gold size, but no oil should be used excepting that contained in the ground white lead. The inequalities in the castings should be filled up with hard stopping, specially made

for the purpose. Sometimes "gold paint," *i.e.*, powdered bronze mixed with a suitable medium, is employed, and as the bronze is supplied in a variety of colours, some pretty effects may be produced if desired. Ordinary paint may be employed provided that it is mixed with a little baking Japan with no oil. The final coat in this case should be a baking varnish, by which is meant one which is made of such materials that on the application of a high heat it becomes very hard. Such varnishes or Japans are used on iron baths, iron mantelpieces, and other metal work which is "stoved,' that is, baked in a very hot oven.

Ships.—The method of painting ships on the inside does not differ materially from that followed in house painting, but in both cases it of course varies considerably according to the class of vessel or house as the case may be. In a first-class liner, natural wood, highly polished, white or coloured enamels are the rule, while on smaller vessels ordinary paint is usually considered good enough for the purpose. There is one point to which attention should be particularly directed, and that is the finish given to the sheet iron work, which is so largely employed on board ship for separating the rooms, bunks, etc. If these were painted in the ordinary manner it would be found that the surface being cold would have the effect of causing the moisture to condense on the cold surface and to run down in unsightly streaks. To prevent this a very thick coat of oil paint is given, and while it is still wet, powdered cork is thrown on the surface in generous quantities, in fact as much is applied as will stick. When this is dry, it is painted or distempered in the usual manner.

A much better plan, however, is to use cork cut into sheets which are affixed to the iron, and practically insulate it. Compressed cork is now supplied for this and many other purposes. It is composed of granulated cork united under great pressure by means of a special waterproof liquid much stronger and better than ordinary cork, although it is cheaper. Sometimes parts of a building, such as metal work in a roof which is exposed inside, cause a good deal of trouble by the moisture condensing upon it. This may be dealt with in the manner already suggested by using compressed cork.

When we come to the outside or exposed portion of the ship the

question of painting is an entirely different matter. In a first-class liner paint of the best quality is usually employed, but in vessels of lower grade very cheap paints are often used, and this is renewed very frequently. The question of labour is under such circumstances of little importance, as the sailors do the painting when not otherwise engaged. Then the absence of smoke should be noted. The cheap paints wear away quickly, but are soon renewed. A good deal of very poor paint is used on the minor vessels.

The metal work on board ship is frequently painted with aluminium paint on a white ground. The author has seen this class of paint of such inferior quality used on a certain line of ships that it had to be renewed every voyage. If the best quality is selected it should last for a considerable length of time.

In the above remarks we have not dealt with the paint which is applied outside of the ship below water-mark. These paints are usually termed ships' bottom compositions, or anti-fouling paints. They vary considerably in composition but mostly contain arsenic or other material which is destructive of animal life. Many firms make a speciality of this class of paints, and it has been found that special compositions are necessary for ships sailing in different waters; for instance, those going to the tropics, where animal and vegetable life quickly mature, require a more poisonous composition than those sailing in the more temperate climates. Tramp steamers, or those sailing from place to place practically all over the world, are usually coated with a composition which may be regarded as of normal or medium ingredients.

Carts and Barrows.—The best paint for application to barrows and small carts is red lead. Care must be taken to give a coat of varnish as a finish. If desired, a little black may be added to change the colour. A good many barrows and such like articles are painted by the dipping process, and in that case red lead is too heavy a material to use, as it quickly settles in the tank.

Machinery.—Grey paint made by mixing white lead and black is sometimes used for painting machinery, but it is not suitable, as the paint must be of a nature that will resist the action of the oil, which is certain to come upon it from the bearings. Many special machinery paints are made possessing this property, and they are strongly

recommended for use. The parts of the machine must first be thoroughly cleaned, then an "iron filler" should be carefully used to bring all inequalities to a perfectly level surface, care being taken to squeeze the filler in all impressions, so as to fill up the holes. If ordinary paint is used it should be mixed with varnish, or a coat of varnish be given. Metallic zinc grey (*q.v.*) is sometimes used for machinery. The first coats of parts of machines are often done by the dipping process, which is described elsewhere. The iron filler above referred to can be purchased ready made, or it can be composed of fine silica and whiting (about half as much whiting as silica), adding a little black. This is ground in equal quantities with good Japan and boiled linseed oil.

Breweries.—It might not at first sight be thought that any special paint would be required for use in breweries, yet as a matter of fact malted liquors are very susceptible to certain odours, and hence the greatest care must be taken in selecting paints for this purpose. Dr. Maximilian Toch, in his very practical work, "The Chemistry of Mixed Paints," deals with the subject at some length. He says: "The materials which do not affect malted liquors in any degree are the linseed oil paints, the turpentine varnishes, the benzine and naphtha paints, and the alcohol varnishes. Turpentine is absorbed to a very small degree by malted liquors, but without any deleterious effect. Benzine and naphtha, particularly the benzine of 62 degrees gravity, is not absorbed at all, and most gum resins are particularly suited for breweries. The resins which should not be used in any brewery are those of the pine tar variety or of the coal tar and pitch class. The enamels used in breweries for decorative and preservative purposes are nearly all harmless, there being only one harmful sample that ever came to the author's notice, and that contained a small amount of acetate of amyl."

Dr. Toch recommends that a black waterproof paint be used on the walls and the ceilings of the fermentation rooms, so that the growth of any mould would at once be noticed, the first growth of a mould such as mycelium being always white. He strongly deprecates the use of paint containing tar or amyl acetate, high grade gum dissolved in bisulphide of carbon and cold water paints, the first and second named because of the objectionable smell, and the

last because it affords a nursery for the production of mould owing to the casein contained.

Floors. - In finishing ordinary floors, which are not to receive a covering, such as linoleum, a stain spirit varnish is frequently used, but this possesses very little resistance to wear. A much better plan is to first give a coat of bleached knotting followed by two coats of floor varnish. If the floor is to be stained a coat of linseed oil and turpentine should be first given to the raw wood. This will hold up the stain and prevent any parts becoming dark. There should be more turpentine than oil, and the mixture should be well brushed into the pores of the wood. This should be followed by a coat of stain and finished with one or two coats of floor varnish.

In finishing oak or other hardwoods a different process is followed, namely, that of first applying a hardwood filler. This is thinned with turpentine and rubbed with a brush into the pores of the wood. The superfluous filler is then scraped off, and one coat of knotting is given followed by two coats of floor varnish. In this work it is sometimes deemed desirable to rub to a dull finish by means of powdered pumice stone and water, which gives a very pleasing effect.

Although paints are not much used in this country on floors, preference being given to stains, used either with a varnish or wax finish they are very useful for certain positions, as for example, school-rooms, passage-ways, public halls, etc. Dr. Toch, in the work already quoted, says: "It is quite true that in former years floor paints were good linseed oil paints which dried in from twenty-four to forty-eight hours. The film was never hard, and owing to the large amount of linseed oil used in the manufacture of these paints they wore very badly. The present practice is to combine for floor paints the inert pigments and hard-drying varnishes. A floor paint should dry sufficiently hard over night so as to show no scratch or heel mark in the morning. For the lighter shades, including the grey paints, lithopone forms an ideal pigment and China wood oil answers the purpose of a vehicle far better than linseed oil. A resin varnish cooked with China wood oil which has been properly neutralized gives a tough, elastic, and waterproof film on the floor which cannot be obtained by the use of the old-

fashioned varnishes, if the time of drying be taken into consideration." It should be added that floor paints are made ready for use, although their sale is very limited.

Pine, natural finish of.—Occasionally it is found desirable, principally for economical reasons, to finish ordinary pine with a natural finish, *i.e.*, not to paint but to stain and varnish it. A familiar instance will be a corrugated iron church fitted on the inside with match-lining of pine, where three or four coats of paint would be too expensive. The method followed is:—Give the wood two coats of size, with perhaps a little stain, and then varnish. The knots should be previously treated with the lightest shellac varnish or knotting, as otherwise they will darken and spoil the appearance of the work. Although size is used to a considerable extent one way and another in painting operations, it is not a reliable article, principally because it is affected so materially by the humidity in the atmosphere. A better material is what is known as "liquid filler." This is a sort of varnish to which has been added some material which will fill up the pores of the wood, and hence give a level surface, to which a final coat of varnish may be applied. The filling material is usually cornflour, but in the best varieties silex or finely powdered silica is used. Where time and money are of very great importance a material may be used composed of stain filler and varnish combined. This, however, will require a satin coat of varnish over to produce a good result.

When liquid filler is employed it is unnecessary to use size, as the filling material contained answers the same purpose. Sometimes liquid filler and stain combined are used, and where great economy is necessary, the work may be finished with two coats, namely the first stain and liquid filler and the last coat good church oak.

Brickwork.—It is somewhat remarkable that although brickwork in the United States and Canada is very frequently painted, yet in this country it is rarely treated in that manner. The very best pressed bricks do not require the application of paint, but those of a more absorbent nature are greatly improved if paint is applied. The improvement consists principally in the fact that the rain is excluded. It is possibly because the very absorbent

bricks use up so much paint that the method is not more usually followed.

The first thing to be done in painting brickwork is to rake out the mortar joints. A thick coat of paint mixed with plenty of oil should then be given, and a second coat if necessary, because some bricks will take up the oil almost like a sponge. The next thing to be done is to stop the joints and all inequalities with hard stopping, as described elsewhere. This must be used freely in order to obtain as level a surface as is practicable. The oil in the stopping will not be absorbed provided that the coat or coats of paint underneath have been of the correct composition. When the stopping is fairly hard a good "round" coat of paint should be given, then a third and even a fourth, taking care to have alternate sharp and oily coats as is usual in all painted work. The finishing coat may be either oily or flat as the case may require; but if the latter is preferred, because the oil coat shows up the inequalities, it must be not a flat coat in the ordinary sense, but one which has a fair proportion of oil in order to bind the materials together, and upon this must be dusted ground brickdust, if a yellow finish is required, or dry oxide of iron if a red finish is wanted. An even better method is to use for the final coat the special paints made for application to brick. These are bound with suitable material and dry hard without gloss. They may be had in several different colours.

When the wall is finished in the manner described it is then necessary to rule in lines representing the joints of the brick. This may be done by means of a straight-edge, and a workman who is a good liner, *i.e.*, one who can strike a straight and firm line, can do the work very expeditiously. The straight-edge is marked with spaces 9 inches and 4½ inches to represent the stretchers and headers, and the upright joints are drawn by hand without guidance, and without much difficulty. If desired, of course, the straight-edge may be used vertically for the same purpose. Special brushes not unlike a large tooth-brush are made for the purpose of lining in the joints, which may be either white, black, or coloured, as may be desired.

Not infrequently one comes across arches which present a very dilapidated appearance owing to poor mortar having been used in

their construction, or sometimes from the fact that the bricks composing the arch, being "rubbers," are too soft to withstand the weather. In such a case these arches may be successfully treated in the manner described, without it being necessary to paint the whole of the wall. The finish, of course, should accord with that of the surrounding brickwork.

Blackboards.—In the erection of schools, technical colleges, etc., it is often desired to finish off a portion of a plastered wall to form a blackboard which may be written or drawn upon with chalk. Although there are many compositions sold for the purpose, such as Ripolin slate-preparations, made in various colours, painters quite frequently mix their own paints. If on plaster, all cracks and holes should be stopped with plaster of Paris, mixed to a thick consistency with the addition of a little blue paint, and when quite dry, the work should be sand-papered until smooth. The next operation is to hang white blank wall paper over the surface, taking care to butt the joints, if any, and to rub out all blisters. When dry the paper is primed with oil paint and afterwards rubbed down with fine steel wool or glass paper. Two coats of blackboard slating are then applied, such, for instance, as made with one gallon of alcohol added to one pint of liquid shellac, half a pint of ivory drop black in turpentine, five ounces of powdered emery, and two ounces of ultramarine blue, or equal parts of powdered pumice stone and red lead ground to a paste in a mixture of turpentine and varnish may be used. A little lamp black is added to produce the dark colour, and the mixture is then thinned with turpentine, added in sufficient quantity to make the colour dry perfectly flat. If the surface to be treated is new wood it should be first primed with oil paint, after which two or more coats of slating should be applied.

Teak.—This wood, which is so largely used in railway carriages, for shop fronts, and on vessels, requires a special treatment. It should first be given a coat of special teak varnish, which fills up the pores of the wood. Sometimes two coats of this may be necessary, so as to stop absorption of moisture. The finish should be two coats of good elastic carriage varnish, or the last coat may be a special varnish made for teak which may be obtained. It is advisable to

paint the back of all teak wood, wherever placed, with two coats of oil paint so as to keep out moisture from this source.

Factories and Workshops.—The Factory and Workshop Act of 1901 renders it compulsory on the occupier to cause the inside of such buildings to be lime-washed at least every fourteen months. Washable water paints are sometimes used for the purpose, and then, of course, do not require to be so frequently renewed. On July 1st, 1911, the Secretary of State made the following order:—

"In pursuance of section 1 (4) of the Factory and Workshop Act, 1901 I hereby grant to all factories and parts of factories which have been painted with at least two coats of a washable water paint as defined below, and are repainted with at least one coat of such paint once in every three years, a special exception that the provisions in sub-section (3) of the said section with respect to limewashing shall not apply thereto. Provided—

"(1) That the paint shall be washed at least once in every fourteen months.

"(2) That the name of the paint used and the name and address of the makers of the paint, together with a certificate, in the form shown in the schedule hereto, from the makers of the paint, and the date of the original painting and of each washing and repainting shall be entered in or attached to the General Register:

"(3) That nothing in this order shall be taken to affect the obligation of keeping the factory in a cleanly state, as prescribed by sub-section (1) of the said section;

"(4) That if it appear to an inspector that any part of a factory to which the exception applies is not in a cleanly state, he may, by written notice, require the occupier to limewash, wash, or paint the same; and in the event of the occupier failing to comply with such requisitions within two months from the date of the notice, the special exception shall cease to apply to such part of a factory.

"In this order a washable water paint means a washable paint which when finished for use contains—

"(i.) At least half its weight of solid pigment containing not less than twenty-five parts by weight of zinc sulphide as zinc white (lithopone) in each hundred parts by weight of solid pigment;

"(ii.) At least ten parts by weight of oil and varnish to each hundred parts by weight of solid pigment."

It should be added that some makers of washable paints in which lithopone is not used take a strong objection to the wording of this order.

Pitch Pine.—As this wood is of a resinous character it is not desirable to treat it with water stain. Either spirit or oil stain should be used in preference—the former if the work is to be hurried, but if time permits oil stain should be used. Equal quantities of both oil and turpentine should be mixed with the necessary colouring matter, and a little liquid drier. This should be given three days for hardening, and may then be wax polished without difficulty. If the pitch pine forms part of a floor it should be twice wax polished, being rubbed down with No. 1 glass paper between the coats. The wax for the finish should be applied by an ordinary pound brush and allowed to dry. An ordinary soft scrubbing brush may then be used for the polishing, followed by a brisk rubbing with scrim cloth rolled round the brush, and finally a soft calico to give a finishing light rub. Weighted brushes are also made for the purpose, or there are special brushes to be had which may be fixed to the feet of the operator. This is the method largely followed on the Continent.

Gasometers.—In the manufacture and storage of coal gas various fumes are given off which have a serious effect on any paint containing lead. For example, sulphurous and ammoniacal fumes cause white lead to become a dirty brown or black. Some years ago the owner of a considerable number of small houses built close to a South London gasworks sued the gas company because paint on the property mentioned was greatly discoloured. Doubtless this paint was lead, and the result was only a natural one. Paint for gasometers and for all work within reach of the fumes given off should be of a special character, and contain a proportion of inert materials, but certainly not lead.

Antimony paint is largely used for this purpose as it resists the fumes and remains white.

Zinc oxide or an enamel made with a zinc oxide base is often used most successfully.

Seaside.—Paint, especially when it is made of white lead, is soon affected adversely by the action of sea air. The linseed oil contained in the paint seems under such conditions to lose its binding properties, and to become "chalky," *i.e.*, it quickly reaches a condition when it will come off on the hand rubbed over it almost like improperly bound whitewash. If a piece of black cloth be rubbed over the surface, white shows on it. The paint which experience has proved the most durable for woodwork at the seaside is zinc oxide for a finishing coat, and if a little good varnish is added it is a distinct advantage. A mixture of zinc oxide and white lead in equal proportions is sometimes used with success, but it is probable that antimony paint (oxide) would also prove serviceable.

Chemical Works, Laboratories and Lavatories.—White lead should on no account be used in these situations, as it is sure to be affected by the fumes which more or less abound in such places. A paint free from lead, such as is recommended for use under the head of "Gasometers," should be employed instead, although zinc oxide is frequently used with complete success.

Felting Down.—This process consists of rubbing a varnished or painted surface with finely powdered pumice stone and water, a pad of felt being used for the purpose. Previous to commencing the operation of felting down, it must be seen that the varnished surface to be treated is thoroughly hard and free from specks. Unless this is the case, the pumice powder is liable to go into the varnish and bury itself as it were. If there are any specks they are very likely to show up on the finished work. The materials required are finely ground pumice powder, water, and a piece of thick felt, a sponge, and a chamois leather. Very frequently, instead of a plain piece of felt, a specially made pad, such as that shown in Figure 32, is used. With the pumice in a saucer, and the water at hand, the work is begun by moistening the felt pad with water, dipping into the powder so that some of that material adheres. The work is then rubbed lightly and continued until the surface is uniformly dull in appearance. To ascertain when this stage has been reached it is necessary to sponge the rubbed parts with water from time to time during the process. A large surface is usually rubbed in a circular direction, but it may be necessary to rub simply up and down in

other cases. When the felting is finished, the surface should be thoroughly washed with a sponge, using a brush as well if necessary, and then it should be dried with a chamois leather. Great care must be taken not to rub one place more than another, and to keep the powder and surface free from grit likely to scrape the varnish when rubbing. Unless the washing off is done with great care some little portions of the powdered pumice may be left behind, which will adversely affect any coat of varnish afterwards applied.

Staining Wood—(Exterior).—There are a variety of ways of finishing wood exposed to the weather. If it is oak the best method is probably to give two or more coats of linseed oil to which has been added a little turpentine. Pine or similar soft wood may be stained very economically by using such material as "Carbolineum Avenarius" or "Solignum." Both these materials may be varnished, if desired, with special varnish supplied for the purpose. A material named "Mykantin" has just been introduced by Messrs. Meister, Lucius and Brüning and bids fair to be a success. Under the head of "Specifications" will be noted that stain added to benzene and raw linseed oil may be used for this purpose. Benzene in this case takes the place of turpentine but it has the advantage of penetrating farther into the wood carrying the stain with it and therefore gives a better protection against decay. In half-timber work this method may be followed with safety.

Wax polishing.—Perhaps the most pleasing manner in which to finish hardwood such as walnut, furniture, or floors, is to give a thorough polishing in wax. Beeswax is used for the purpose, and this is shredded into a pan and melted gradually over the fire. Turpentine should be added in a sufficient quantity until the wax is to the consistency of soft butter in hot weather. It should be allowed to cool, and then should be applied with a brush, allowed to dry, and rubbed vigorously with a coarse piece of canvas or even with an ordinary scrubbing brush, and finally with soft woollen or cotton cloth until a polish is obtained. A second coat of wax should then be applied and the surface again polished until a satisfactory result is obtained. A preparation containing wax polish may be obtained which is claimed to have advantages over the home-made material.

Colouring Putty.—Many painters neglect to colour their putty,

although it is a very easy matter to get it approximately the colour required in the second and third coats. If the work is white or cream it does not of course require to be coloured. In other cases a little oil colour of a required tint may be added to the putty with advantage and should be well incorporated with it. If the putty is very oily and soft dry colour may be used, although this is not recommended.

Removal of Tar.—If a surface such as a fence has been tarred, it is practically an impossibility to remove the tar, but in many cases tar has become smeared over a surface which it is desired to paint, and it becomes a question of how to deal with it in order to get the paint to dry, which of course it will not do unless some special treatment is given. The tar may be softened by the application of benzene or benzol, which, being an excellent solvent, is the best material to use. The tar can then be scraped off to a considerable extent. Two coats of shellac varnish, or best patent knotting, should then be applied, and the surface can then be painted on without any fear of danger resulting.

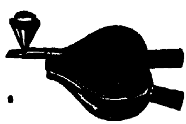

FIG. 1.—Bellows for blowing sand upon a wet painted surface.

Sanding Paint.—In the United States of America the process of sanding paint is very largely carried on, principally in connection with architectural features, such as cornices, window dressings, etc., which are made of galvanized iron, and are then sanded to imitate stone. Frequently in stone buildings the dressings, which are often of a very elaborate character, are thus sanded, the chippings of the stone forming the main building being pulverized for the purpose, so as to retain the same appearance. In addition to its application for the purpose named, sand may be applied to paint with considerable advantage where great durability is required. The work is brought up in the usual way, and a very thick coat of paint is then given. The sand is then blown on the surface, a pair of specially made bellows being used for the purpose. One of these is illustrated in Figure 1.

Enamelling (interior) on Wood, Iron, Stone, etc.—Some fifteen

to twenty years ago, the use of enamelled work was almost wholly confined to mansions or buildings of high class, and the work was done by applying a large number of coats, sometimes as many as ten, each being rubbed down with powdered pumice and water, a final coat or coats of a very light varnish being given. But of late years there have been placed on the market many good enamels which greatly reduce the cost of labour, and yet give an excellent result. These enamels, if properly applied, give a good glossy finish—some are made to dry flat—which when allowed sufficient time to thoroughly harden, become exceedingly durable both when used inside and out. A different quality, it should be mentioned, is used in each case.

Success in enamelling depends upon the under surface being properly prepared, and if the enamel be regarded for the time being as merely a varnish, better results will be produced, because the painter will know that it is necessary to have a perfectly level and white surface before any enamel is applied at all. The usual plan followed for the production of the highest class work is to treat the knots and sappy portions, if any, with white shellac, and then to prime with one thin coat of white lead, which should be well brushed into the wood. After nail holes and imperfections are made good, a coat of white shellac is sometimes given over the whole of the work, and upon this, three coats of white paint, made of a mixture of white lead and zinc oxide in the proportion of three to two, are followed by a coat of pure zinc oxide. If each coat is allowed to become thoroughly dry before another is applied, and the surface is nicely sandpapered, the result will be a surface which will give a good foundation to the enamel. This should be applied rather freely, and if of good quality, all brush marks will rapidly disappear. In first class work a second coat of enamel may be applied, the first being rubbed down to a semi-gloss. It may be remarked that a special workman is usually selected to apply enamel, as it is not every painter who can do the work successfully. The finishing coat of zinc should be rather flat, and the coats underneath it alternately flat and oily, as in the case of ordinary paint work. If it is desired to tint the enamel, this can be done by adding suitable stainers, but they must be of the finest quality, or trouble will

result. There are now on the market a number of under coats which are used for enamel work, and these are mostly composed of lithopone and yield good results, and considerably cheaper work.

Very cheap work may be done on old woodwork by applying one coat of paint or washable distemper with another coat of oil paint on top, but such methods are not desirable. Enamel work should be done well or not at all. In applying enamel it is necessary to see that there is an absence of dust in the room, and that the weather conditions are favourable.

Filler for Porous Woods.—The application of a filling-up material for very large pores or open wood is necessary as a preliminary operation. The following formula is sometimes used:—Mix corn starch or flour with shellac varnish on a slab and work this into the wood. After it becomes quite dry, sandpaper smooth. The finish on this is usually as follows:—Polish with shellac, using a cloth rubber, dipped in a little raw linseed oil. The shellac is very thin, and only a few drops of oil are used on the rubber, after the manner of French polishing. Upon this, if desired, ordinary good varnish may be applied, leaving a full gloss coat.

Another special filler, in which glue figures, may be made as follows:—Soak a pound of good glue in 7 lbs. of water until it becomes soft, then set on the stove, in a vessel containing hot water, and let it remain until the glue is perfectly dissolved. Add to it while hot from 1 to 2 lbs. of litharge and 2 lbs. of plaster of Paris. Mix all perfectly together.

Here is a good paste filler that does not harden too rapidly. It is tough and does not shrink in the pores of the wood. Make some flour paste in the usual way, and boil it. Allow it to get cold before using, and have it so stiff that it will just run when poured upon a mixing board. Now separately mix whiting and linseed oil to the same consistency as the flour paste, then mix the two together and incorporate well. For thinning the mass use benzine, or a similar cheap fluid, and liquid drier in the proportions required to make the stuff dry right. It will require some experimenting to get the mass rightly proportioned as to its ingredients, so as to get it to dry and harden and act in the usual paste filler way. If you are not successful with the first batch, note the proportions you

used, and change them slightly. The flour, whiting and oil may differ, as they undoubtedly do in many cases.

The above recipes are quoted by Mr. A. Ashmun Kelly, who gives also the following recipes for fillers for various other woods :—

Mahogany. –Take equal parts by weight of whiting, plaster of Paris, fine pumice powder and litharge, to which may be added a little steatite or soapstone, and Vandyke brown, ochre or burnt sienna. Mix, then make to a paste with 1 pint of Japan, 2 pints of boiled oil, and 3 pints of turpentine, and grind in a handmill.

Walnut.—Mix together equal parts of rye flour and China clay, colouring with burnt umber; mix to a paste with a thinner made from 2 parts of turpentine, 1 part boiled oil, and 2 parts Japan gold-size.

Ebony.—Make a filler with plaster of Paris and lamp black, mix to a paste with either Japan or gold-size.

Golden Oak.– Take 10 lbs. of good uncoloured paste filler and add to it 4 ozs. of burnt umber and ½ pint of best asphaltum varnish. Mix to a paste.

Dark Oak.—The filler for ebony will do also for dark oak, or burnt umber may be used in place of lamp black.

Redwood.—To 1 lb. of corn starch add 1 quart of turpentine, 4 ozs. of dry burnt sienna, and 1 tablespoonful each of raw oil and brown Japan. Mix well, preferably in a paint mill.

Oak.—Gilder's whiting, 5 lbs.; plaster of Paris, 2 lbs.; dry burnt sienna, ½ oz.; raw linseed oil, 1 quart; turpentine 1 pint, white shellac, ½ pint; mix together.

Or, mix together 2 parts of turpentine, 1 part of raw oil, and sufficient Japan to dry the filler in the usual time; add to this liquid fine silica to form a paste.

Or, mix together equal parts by weight of raw oil, Japan gold-size and turpentine. Add burnt umber in oil, or Vandyke brown, with a little drop-black in oil, to colour the mass. All such mixtures are better for being run through a hand paint mill, in the absence of which mix well and run through a fine sieve.

Cherry.—Best whiting, 5 lbs.; plaster of Paris, 2 lbs.; burnt sienna dry, 1½ oz.; Venetian red, dry, 1 oz.; boiled oil, 1 quart;

turpentine, 1 pint; brown Japan, 1 pint. Silica may be used in the place of the whiting and plaster.

Light Woods.—Ordinary light paste filler will do for any light coloured wood that requires paste filling. But a little colour may be added to tinge the paste and suit the colour of the wood, for even the whitest wood has some colour. A published formula reads as follows:—Gilder's whiting, 5 lbs.; plaster of Paris, 3 lbs.; corn starch, a lb.; calcined magnesia, 3 oz.; raw oil, 2 quarts; brown Japan, 1 quart; turpentine, 1 pint. Mix.

Walnut.—Mix together 3 lbs. burnt umber and 1 lb. burnt sienna, both ground in oil, and add a quart of turpentine and a pint of brown Japan driers. Mix to a paste.

Ash.—This being a very light wood it requires a filler with no colour added. It is also a very open-pored wood. Mix together 2 parts of bleached linseed oil, 3 parts of pale Japan gold-size, and 1 part of turpentine then add floated silica to form a paste. Thin for use with turpentine.

White Pine.—Surface with bleached shellac varnish.

Birch.—Surface with white or bleached shellac, one with 1 lb. of gum to the gallon of alcohol.

Red Gum.—Follow the same method as advised for birch.

Beech.—Same as for birch and red gum.

Chestnut.—This is a very coarse-grained wood, and the filler needs to be rather stiff. Use plain silica filler, either slightly stained to match colour of wood, or not.

Cherry.—Being a close-grained wood it requires only surfacing with shellac, same as pine, etc.

Cypress.—Fill with either a heavy shellac or liquid filler, according to price. It is a close-grained wood.

Elm.—The elms are coarse-grained and require the same filler as chestnut.

Maple.—Surface or fill with white shellac varnish.

Pitch Pine.—Fill with white shellac.

Rosewood.—A very coarse-grained wood and needs a spare filler, that indicated for mahogany answering the purpose.

Sycamore.—A very close-grained wood and may be filled or surfaced with orange-shellac.

To keep Insects from Fresh Paint.

Few things are more annoying to a painter than to find, after he has taken great pains to finish a building, that various flying insects such as gnats, etc., have adhered and spoiled the appearance of the work. To prevent this trouble, half a pint of camphor oil should be added to every gallon of linseed oil. This will slightly retard the drying of the paint, although it will not be injurious to its wearing qualities.

Taking away the Smell of Paint.

Ordinary white lead paint, made from linseed oil and turpentine, possesses a distinct odour which is much objected to by some people, particularly those in a delicate state of health. If lead is used, the best plan to follow to get rid of the smell is to place several pails of water in the room. This will absorb some of the lead fumes, and it will be found covered with an oily film after a few hours. Milk is even better still, and may be used in the same way. Still another method is to place a liberal quantity of fresh hay, steeped in water, in the room, and juniper berries are said to have the same effect.

It is a fact, the reason for which has not thus far been demonstrated, that zinc oxide when mixed with turpentine and linseed oil has not the same objectionable smell as white lead, and it may therefore be used on an interior with safety.

How Paint Dries.

The word "dries" as used in the above heading may be properly applied to distemper, which consists of chalk mixed with water with a little size to bind the particles together. In this case the distemper dries and becomes more or less hard by the simple evaporation of the water, and it is important to note that distemper is very much lighter in colour when dry than it is when wet.

Oil paint, however, becomes hard in an entirely different manner. It does so by absorbing oxygen from the atmosphere, and thereby becomes solid. Driers, as already explained, are materials which have a more or less considerable affinity. They are, therefore,

added to paint in small quantities to facilitate the drying or hardening. It will be seen from what has been said that a supply of oxygen in the form of pure air is quite necessary in order that oil paint may properly solidify, but it may be observed that the practice sometimes resorted to of shutting up all windows, and lighting gas jets when it is wished to dry paint on the inside of a house quickly is one which is altogether objectionable. The combustion of the gas yields moisture, and retards the drying of the oil paint, which cannot possibly be assisted.

The Best Time to Paint.

A general impression appears to prevail that the best time to execute painting work is in the early spring. This, however, is a mistake, as at that period of the year, the air is more or less saturated with moisture, a condition which has a bad effect on the durability of the paint. The best time to paint is doubtless the autumn, particularly if arrangements can be made to apply the paint after several days of fine hot weather, which will have the effect of making the work substantially dry. Another popular delusion is that paint work cannot successfully be done in cold weather. The fact is that, provided the air is free from humidity, a cold day is almost as good as a warm one for painting, although in applying varnish and enamels it will be found that they will stiffen and become a little difficult to apply.

CHAPTER V

HOW PAINT AND VARNISH SHOULD BE APPLIED

THE best paint and varnish in the world may be spoiled if they are unskilfully applied, and this fact is often overlooked by those responsible. The condition of the painting trade as far as house property is concerned is peculiar, inasmuch as at certain times of the year painters have comparatively nothing to do, and at other times, such, for instance, as in the Spring, more than they can comfortably manage. Under these circumstances incompetent men are sometimes engaged and the results are distinctly bad.

It need hardly be said that the first essential in old painted and varnished work is to thoroughly clean the surface and free it from grease. In many cases which occur where paint and varnish remains sticky, the defect may be accurately attributed to dirt or grease in some form, and it will often be found that sticky parts are those which are most handled, such, for instance, as the stiles of a door close to the lock or handle, church seats, etc. All work of this character should be thoroughly cleaned with sugar soap, a special variety made for painters, or it may be scrubbed with water to which a little ammonia has been added. In the case of very dirty work one of the paint removers mentioned elsewhere may be applied, but it must be wiped off almost immediately, so as not to remove the paint or varnish.

As to the actual appearance of the paint, it will depend upon its quality and kind. As a general guide it may be said that all ordinary paint should be well brushed out, that is to say, as little as possible put on the surface; this, of course, within reasonable limits. It is an old saying that oil paint should be applied as though it cost a guinea an ounce. Certainly two thin coats of paint are very much more durable than one thick coat. Varnish, on the contrary, is flowed on, and—again within reasonable limits—as much as possible

should be put on. To prevent any possibility of running, the expert workman always finishes with an upward stroke of the brush at the bottom of the work, such as the bottom rail of the door.

As to the actual manipulation of the brush--a subject obviously of great importance--Mr. C. E. Oliver, one of the most skilful brush experts the writer ever came across, has kindly written the following: –

Just as there are many kinds of brushes to suit the varied requirements of the painting trade, so are there many ways of manipulating a brush to satisfy the peculiar properties of the various materials used. It would be just as insane for a painter to apply always the same method, as for a doctor to supply always the same physic, regardless of the complaint. The painter should be able to adjust his method and "touch" to suit the material he is applying, and the want of ability to do so has led to many disastrous results.

There is a greater demand for this skill to-day than there ever was. With the increased output of ready-to-use materials, of the composition of which the painter knows little or nothing, and seldom troubles to inquire, with the fine-drawn specifications where two coats are expected to do what is to be considered the work of four, it is more than ever important that the painter should do all in his power to equip himself to meet the present conditions. His first duty should be to learn all he can concerning the special attributes of the materials he is called upon to use, and his second, to see that he is properly equipped to do them full justice. Paints generally may be divided into two main classes; the "flowing" and the "non-flowing." Each of these classes contain varieties as widely divergent as "gloss and flat," "quick-setting" and "slow-setting."

It should be the painter's first care to find out to which class and variety the material he is to use belongs, as this will determine his method of application. If the paint is of his own mixing, he will have learned sufficient for his purpose. If it comes to him ready for use, he should read carefully the directions accompanying it; they are generally sufficient to indicate to which class or variety the paint belongs, though we have seen instances where such was not the case, and the user was left to find out for himself as best he might. The most important point is whether the material is of the

"flowing" or of the "non-flowing" type, as the application of these two is entirely opposite in character, and the next is whether it is "quick" setting or "slow." It will be found as a general rule that all flowing materials are fairly quick setting. They must set or they would run. It can also be taken for granted that all gloss enamels and varnishes are of the "flowing" type, while the undercoatings and oil paints are of the non-flowing class. This latter, however, has exceptions, for there are now on the market some oil paints and under coatings which have distinct flowing qualities, and it is very important to know this before commencing to paint.

Let us take as an extreme example the application of two materials.

(1) An oil paint of the non-flowing class and slow setting variety.

(2) A "flat enamel," "flowing and quick setting."

In the former we have a material which allows plenty of time for spreading, but which requires crossing and fining down, and finally must be laid off so lightly that no brush marks are visible. It is here that the painter's skill is most necessary, and it is not too much to say that there are many old hands who have never acquired the art, and plenty of young ones who will never get the opportunity of doing so.

The first requisite for the application of this class of paint is a fine, flexible brush. Much good work has been done in the past with the well-broken-in pound brush, but the changed conditions to which we have alluded, coupled with the difficulty of bringing them to the right condition at the right moment, has led to the adoption of a secondary brush for laying off, generally of the full flat black bristle variety, while the pound brush is only used for the actual spreading of the paint. There is much to be said in favour of this method. It does not much matter whether the pound brush is new or old; the fine black brush will remove the brush marks. Another and most important point is the fact that one cannot lay off paint finely with a brush which is charged with colour. The final touch must be done with a practically dry brush, and for this reason much time used to be spent in rubbing out the brush, generally on the wall if available, in order to bring the brush to a fit condition for laying off.

There was no need of a secondary brush when the number of coats allowed was sufficiently ample to allow of each one being spread out to its utmost limit. By the time a panel was covered the brush was nearly dry and fit for laying off. No such brushing out is possible now, and the successful painter is one who can apply a good round coat and still get it fine and free from brush marks; and the use of a secondary brush, with its fine black bristles kept almost dry, will help him to do so. It is quite on a par with the grainer and his "badger softener," and is at the same time a splendid way of preparing these brushes for use afterwards in enamel or varnish.

The application of flat enamel, on the other hand, is altogether different. Here we have a material which is possessed of the property of flowing out rendering the fine laying off unnecessary. The principal aim must be to spread it as quickly and evenly as possible, and then leave it severely alone. Small sections, such as panels, etc., should be laid in freely, crossed once horizontally and laid off vertically with a firm hand. Walls and other large surfaces should not be crossed horizontally at all. The edge should be kept alive and the laying off done in a slanting direction from the edge inwards, and never in the opposite direction, or you will get marks of the brush end and flashes on the parts which have commenced to "set." The method is precisely the same as for distempering. The soft, pliable pound brush which we used for the oil paint is quite useless for the application of flat enamel, or indeed for any of the flowing materials. A fine bristle brush which has been kept suspended in turps is the most suitable, and the larger the brush is, within reason, the better. It is surprising how easy an enamel will work in a four-inch flat brush, and how solid is the result. You will find that the larger the brush you can conveniently use the better and cleaner will be the result, and I am sure the governor will have no cause to complain.

The "setting" point of a material is one which must be quickly determined if good results are to be obtained. No doubt you have seen the "rucked" or "rippled" surface which a painter will obtain with a varnish or enamel with which he is not familiar. This is caused by passing the brush too lightly over the surface

which has commenced to set, rucking it up. There is one way of removing this rippled surface, and it must be done quickly. Wash out the brush in turps and "twirl" round until dry, then pass it firmly, but very slowly, over the surface, starting at the bottom and travelling upwards, just lapping over each stroke. The pressure must be sufficient to disturb the coating right through. It takes out the ripples and brings the under surface which has not yet set to the front. This will flow out and the situation will be saved. I have seen a nasty run taken from the middle of a flank wall by this method. It also demonstrates the correct way of laying off a thick, quick-setting enamel or varnish. Prevention is always better than cure, so the painter should learn to apply all flowing materials with a quick, firm hand, saving his lighter touches for those which do not possess any flowing ability. The future of the paint industry will no doubt call for all materials, be they preparatory or finish, to be sent out by the manufacturer in a "flowing" medium; by that means only shall we, in the face of a dearth of skilled painters in this age of non-apprenticeship, be able to obtain that excellent finish for which our British painters have justly been renowned.

CHAPTER VI

PAINT AND COLOUR MIXING

In order to make this book complete it is deemed advisable to include some instruction on paint and colour mixing, although full instructions have been given on the subject in the author's book "Paint and Colour Mixing," the fourth edition of which was published in 1910.

The usual plan adopted in mixing paint is to place a little oil in the can so as to prevent the pigment sticking. The white lead, zinc oxide, or whatever other pigment may be used, is then put in the can, oil and afterwards turpentine are added, and the whole mass is beaten up by means of a stick or paddle. This is a very slow and tedious process, but, remarkable to relate, it is one which is followed by the majority of painters. A far better way is to use a paint mixing machine, which may be purchased for a few guineas and which will turn out as much thoroughly mixed paint in a few minutes as can be obtained by mixing in the ordinary way by hand in an hour or more. In conjunction with the paint mixing machine, or if even the hand mixing is resorted to, it is very necessary that strainers or a series of strainers are used to remove any small and hard dried particles which may be in the paint, and which would greatly mar the appearance of the finished work. There are various types of paint mixing machines on the market, varying largely in size and efficiency. The latest product of this kind is the "Decorator" mixer, which is made in two sizes, one to hold a gallon and the other half a gallon. The construction is simple and the actual mixing parts are made of gun-metal. To facilitate cleaning the mixer can be lifted out of place on an iron hook which is provided to receive it. This container is swivelled, so that the contents may be poured out into a paint can very readily. Another paint mixer made by the same firm (Messrs.

Torrance & Son, Ltd., Bitton, Bristol) is entitled the "Little Giant." This holds two and a half gallons and will mix paint in a few minutes. Extra containers to save cleaning for change of colour are supplied.

Under the head of various surfaces to be painted information has already been given as to the best paints to be used. It now only requires to give mixtures for producing various colours, and it should be here observed that opinion varies very largely as to the exact hue of various named colours. In the City and Guilds of London examinations in Painters' and Decorators' Work, work is often required to be done in certain named colours, as, for example, pink, pea green, etc. In the actual examples submitted by students from the various technical schools it is made very clear that no definite understanding exists as to what the colours named, as well

FIG. 2—Paint Mixing Tool.

as others, imply. Pink in the minds of some of the students evidently means anything from a buff to a deep vermilion, while pea green ranges from a sickly light green of no particular tendency down to a green which is almost black. In the following list of colours no proportions are given for the following reason: The strength of colours of different manufacturers vary so very largely that it would be impossible to give proportions, unless one was familiar with the strength of the colours that are to be used, but the instructions may be taken to represent colours of average strength and quality.

In the absence of a proper paint mixer, a revolving barrel butter churn may be used, and it is particularly useful in dealing with red lead, which is notoriously difficult to mix.

A tool which only costs a few pence is that shown in Figure 2. It is made of cast iron, and considerably facilitates the mixing of paint.

Apricot.—Chrome yellow mixed with a little vermilion and a very little lake will produce this colour.

Begonia.—This is a dark red purple, which may be obtained by mixing equal parts of lamp black, Prussian blue and bright red. For a bright begonia additional red should be used.

Brick.—White lead, French ochre and vermilion will produce this colour, the ochre being varied in proportion according to the tint desired.

Bronze Red.—Any bright red may be used with the addition of black and a little yellow or orange.

Carmine.—This is a well-known bright red colour which cannot be imitated, but should be bought ready made.

Carnation Red.—The best way to produce this colour is to take pure vermilion as a base and add carmine and zinc oxide until the desired rich colour is obtained. It should be observed that the colour is not suitable for outside use as it is certain to fade.

Claret.—Venetian red and yellow ochre glazed with crimson is sometimes used to produce this colour, but ultramarine with twice its bulk of carmine, with the addition of a little vermilion, may be used instead, if desired.

Pompeian Red.—Tuscan red tinted with orange and a little red gives a good Pompeian red.

Purple.—The usual method is to mix ultramarine and vermilion with white and perhaps a little crimson lake, but light Indian red, white lead and ultramarine blue may be used instead, if desired.

Rose Colour.—Zinc oxide should be tinted with carmine, which gives a beautiful rose, but it should be noted that this colour is not suitable for outside exposure. The colour called "royal pink" is produced in the same way, but is a little stronger.

Royal Purple.—This colour is best purchased ready made. It is a peculiar red colour which cannot successfully be imitated.

Salmon.—Vermilion with a little lemon chrome yellow added to white lead gives a good salmon colour, but raw sienna, burnt sienna and burnt umber are sometimes used. Some prefer Venetian red, chrome yellow and white.

Signal Red.—This is a very bright red which may be purchased ready made. It can be imitated by mixing orange red, vermilionette and Paris white.

Terra Cotta.—One part of burnt sienna to double the quantity of

white zinc gives a good terra cotta, but Venetian red and orange chrome may be used instead. Burnt umber, mixed with iron oxide and white in different proportions, gives varying and pleasing shades of terra cotta.

Flesh Colour.—Ochre with a little Venetian red is added to white lead or zinc oxide to produce this colour, or orange chrome yellow and Venetian red may be used instead.

Geranium.—This colour is best produced by glazing Indian red with madder lake, but there is no difficulty in obtaining geranium red already mixed.

Indian Red.—This is a well-known colour which is quite permanent and consists chiefly of iron oxide, which may be mixed with any other colour without affecting them or itself being affected.

Light Red.—This colour is also called burnt ochre or burnt Roman ochre, and is obtained by calcining yellow ochre. A red obtained by tinting white base would be termed pink.

Lilac.—Bright Indian red with a little ultramarine blue and a very small quantity of yellow is added to white to produce this colour.

Magenta.—Mix together carmine and vermilion and add a little ultramarine blue.

Old Rose.—White lead or zinc oxide tinted with French ochre, Indian red and a little lamp black will produce this colour.

Plum Colour.—Equal parts of white lead, Indian red and ultramarine blue, will give plum colour, which may also be obtained by mixing together ultramarine blue and carmine with a little white and a little yellow added.

Wine Colour.—To a mixture of carmine add a little ivory black.

Peacock Blue.—This beautiful colour can be made by tinting cobalt with a little white and a little Chinese blue.

Prussian Blue.—This is a very strong and useful colour, and a little goes a long way, so to speak. It is not suitable for using in distemper, but is one of the best blues to use in oil paint. It cannot be imitated, but should be bought ready made. If dry, *i.e.*, in lump form, the best qualities have a peculiar bronze appearance which sometimes is thought to be indication of inferior quality, while the reverse is actually the case.

Sky Blue.—This is mixed in the same way as azure blue, which is practically a synonym.

Biscuit Colour.—If zinc oxide is used as a base and a yellow or ochre with a touch of umber is used to tint it, a variety of pleasing biscuit coloured tints may be obtained.

Buff.—This colour is, of course, very largely used in various schemes of interior decoration. There are many ways of producing it, the commonest being to take French or yellow ochre and use it for tinting white lead or zinc oxide.

Cadmium Yellow.—This colour is purchased ready made and must not be mixed with chrome yellow, emerald green, or any pigment containing copper or lead. Zinc oxide should be used as a base, and cadmium added thereto will produce some exceedingly attractive effects in varying degrees of brilliant yellows.

Antwerp Blue.—This colour is obtained ready made, and Brunswick blue is often used in its place.

Azure Blue.—This colour is practically the same as sky blue, and is made by mixing cobalt with white. As, however, the former colour is expensive, ultramarine and zinc white are frequently employed with the addition of a little green.

Bronze Blue.—Black is added to Prussian blue to produce this colour.

Brunswick Blue.—Prussian blue is lightened with white lead or zinc oxide.

Chinese Blue.—This is a term applied to the highest quality Prussian blue, although it is sometimes applied also to an inferior quality.

French Blue.—Is a cheap grade of ultramarine.

Heliotrope.—A bright red, ultramarine blue, and zinc oxide may be used successfully to produce this colour.

Indigo.—It is very difficult indeed to imitate this colour successfully, but black and Prussian blue may be employed in cases of necessity.

Lavender.—Zinc oxide or white lead is used as a base, to which is added a little carmine and ultramarine with also a little ivory black for outside work, but if inside the black may be omitted and ultramarine and carmine used instead.

Mauve.—This beautiful colour is best obtained ready made, and it should be noted that most varieties have a very greyish appearance when viewed by artificial light. There are several ways of producing the colour, the best probably being to employ 4 parts of cobalt blue, 12 parts of oxide of zinc, and 1 part of carmine lake. If this mixture is too expensive, yellow ochre, blue black, and Venetian red with a little white lead or zinc oxide will give the desired effect.

Cream.—French yellow ochre with a touch of Venetian red added to white lead or zinc oxide gives an excellent cream, but if a particularly pleasing effect is desired Naples yellow added to zinc oxide will give a better colour. Buffs may be considered as practically deep creams.

Chrome Yellow.—This is the well-known yellow so much used by painters. It is a chromate of lead, and although exceedingly useful, possesses the disadvantage of darkening when exposed to impure air.

Gold.—It is sometimes desired to give the appearance of gold, and the best way to do it is to add to golden ochre a little vermilion, or white lead may be tinted with light chrome yellow, French ochre and vermilion

Ivory.—This colour is best produced by tinting zinc oxide with Naples yellow, but a medium chrome yellow added to white is usually employed.

Lemon.—Some varieties of lemon chrome yellow may be used alone and give an excellent result, but some prefer to use chrome yellow added to white lead with a very little green.

Old Gold.—This may be produced by mixing ochre and burnt sienna, or be obtained in the same way as described under the head of "Gold," with a little burnt umber added.

Orange.—Orange chrome yellow can so readily be obtained ready made that no admixture is necessary.

Oxford Ochre.—This is the name applied to yellow ochre of a brilliant shade. As a matter of fact, there is now no real Oxford ochre in existence, the mine having been many years ago exhausted. Sometimes to obtain the brilliancy a little chrome yellow is added.

Portland Stone.—White is used as a base, and the tint is made by adding equal proportions of yellow ochre and raw umber.

Primrose.—This light greenish yellow can be obtained ready made, but if a mixture is necessary use 3 parts of green, 4 parts of yellow, and 10 parts of white.

Stone Colour.—Yellow ochre with a little burnt umber is added to white to produce this well-known colour.

Apple Green.—Chrome green with a little orange chrome is added to white lead or zinc oxide.

Bronze Green.—Use middle chrome green, blue black, and burnt umber. Sometimes yellow and black are added to white.

Emerald Green.—This colour contains a considerable quantity of arsenic, and its use for purposes of tinting has therefore to a great extent died out. Imitation emerald greens which are non-poisonous can be obtained. It is a most brilliant colour and quite near in hue to the green of the spectrum.

Invisible Green. This is made by mixing black with green, which gives a greenish hue to the mixture.

Moss Green.—White lead should be used as a base, and French ochre, bright green and a little lamp black added.

CHAPTER VII

TOOLS AND PLANT

It is not deemed necessary to include in this work a very minute description of the tools and plant used in painting, but it is thought advisable to mention a few of the most important. Some space is given to brushes and their care, because these tools, if of good quality—as they always should be—are quite expensive; while apart from that consideration, cheap or badly cared for brushes are so often the direct cause of bad work that special attention is drawn to them.

BRUSHES.

It may be laid down as a general principle that it does not pay to purchase inferior brushes, and although the first cost of the highest qualities is high, they will, if properly taken care of, last so much longer than inferior articles that they ultimately more than pay for the difference. But the chief advantage of good tools of this character is the greatly superior work which may be done by their aid. It is almost impossible to get good results by using a flabby bristled brush without spring or elasticity. Inferior qualities of painters' brushes are frequently adulterated by the admixture of horse hair, etc. This, however, can be readily detected by pulling out a few of the bristles and examining them under a strong glass. If true hog's hair bristles, they will be found to taper and to have a pointed shaped end, while if horse hair has been used, the end will be cut off square.

It is said that false bristles are now made in such a manner that the above tests will not answer, as they blaze in exactly a similar way to genuine bristles when a light is applied to them. The best

plan is, perhaps, to drop a few bristles on a hot stove lid or gas-stove top, and notice the odour.

There are no natural white bristles, and when one buys a white bristled brush it means that bleaching has been used, which tends

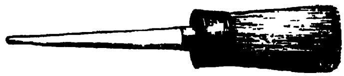

FIG. 3.—Round Ground Brush.

towards destroying the natural elasticity of the bristles, which is perhaps the most important quality for them to possess.

Ground Brushes. These may be considered the principal brushes used by the decorator for applying ordinary paint. They are made

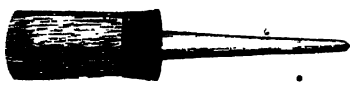

FIG. 4.—Oval Ground Brush

in various forms, some by machinery and others by hand. They vary in size and are marked respectively Nos. 1 to 8. The medium size is used for most work. As the bristles of a new ground brush are too long to apply the paint uniformly, it is usual to use a "bridle,"

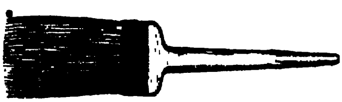

FIG. 5.—One-Knot Ground Brush.

This consists of tying up the bristles by means of a string, carefully wound around the lower portion of them. When the bristles are worn down this bridle is removed. In many varieties of ground brushes two small hooks or their equivalent are provided to receive the ends of the cord, and there are also various forms of bridles which may be partially removed as the bristles wear down.

Sash Tools.—These brushes may be regarded as small pound brushes, and are employed for painting window sashes and other small parts, and also for cutting in where required. It is necessary that they be made of good bristles, and the highest quality of the machine-made variety is growing in favour, as the metal ferrule holds the bristles very securely.

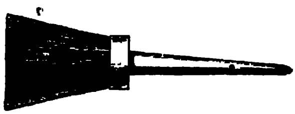

FIG. 6.—Round Duster.

Fitches.—These small brushes are usually made of hog's bristles enclosed in a little ferrule. When they are bevel edged they are used for lining. The ordinary shapes are employed for "cutting in" ornamental painting, etc.

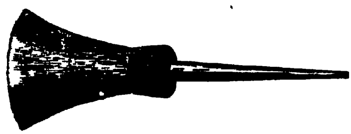

FIG. 7—Watkin's Patent Duster.

Dusters.—There are several forms of dusters, which, as the name implies, are used for removing the dust before the painting is proceeded with. Some patterns are flat and others round. The former are useful when dusting down a staircase, as they may be used between the balusters. They are also of service when dusting jambs, reveals and corners.

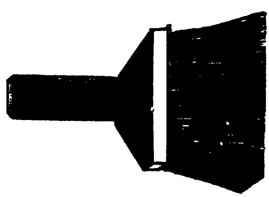

FIG. 8.—Square Duster.

Varnish Brushes.—As a rule the flat or oval brushes are preferred for applying varnish. They are made to taper to a chisel-like point, which is produced, not by grinding, but by placing the bottom of the bristles in a cup or holder which is raised in the

middle, correspondingly to the chisel shape of the upper end to... produced.

Probably the most convenient form of this brush is one recently invented by Mr. C. E. Oliver, which is shown in the illustration, and is known as the "Namel-Var." It is made by Messrs. Hamilton & Co.

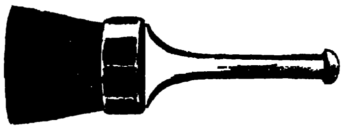

FIG. 9.—The "Namel-Var" Varnish Brush.

This brush is of a shape which may best be described as of a flat oval type, and it possesses several important features which are not usually found in a brush. Its great merit is that it is a clean brush. The plain steel ferrule, being entirely free from rivets, offers no harbourage for dirt or fluff. It may be easily cleaned, the peculiar flat shape of the handle enabling one to twist it in and out, and so clean it from colour and particles of grit, etc., in a very short time. Perhaps the most important point of all is that it is provided with means of suspension, which ensures it being kept clean when not in actual use.

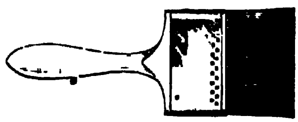

FIG. 10.—Flowing Varnish Brush.

Varnish brushes are often sold as "lily-white," which really means that the bristles have been bleached. There is, however, no advantage in white bristles over grey or black, excepting that they show dirt more plainly. Black bristle brushes are now gaining in favour, because, while being quite as good or even better than the white variety, they are somewhat cheaper and more lasting.

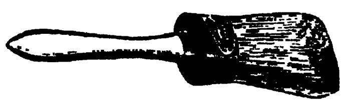

FIG. 11.—Oval Varnish Brush.

Distemper Brushes.—Distemper brushes are employed for apply-

'S whitewash, distemper, washable water paint, etc. They are made in several shapes, some being knotted as shown in engravings,

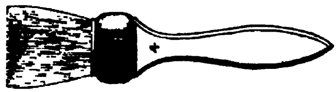

FIG. 12.—Oval Bevelled Varnish Brush.

or there may be three knots, or even a single knot. Other forms are without knots at all. Another form has comparatively short

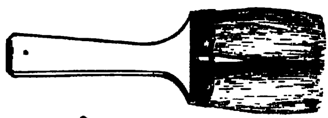

FIG. 13.—Two-Knot Distemper Brush.

bristles, so that it may be used for those paints which are likely to harden in the brush, such as various gypsum products.

Stipplers are also made in various forms. They are large flat

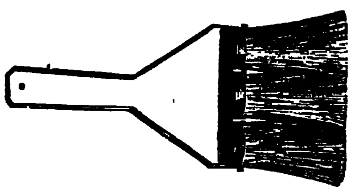

FIG 14.—Three-Knot Copper Wire Bound Distemper Brush.

brushes with a handle at back, and are used to stipple or dab freshly distempered or painted work with a view of breaking up the surface into minute depressions, which gives a softer effect than would otherwise be the case.

The Care of Brushes.—It is of the greatest importance that brushes

be kept in good condition, and this can only be done by giving them constant attention, and seeing that they are thoroughly cleaned before being put away in store. It is usual to place new pound brushes, sash tools, etc., in water to swell the parts and hold the bristles more firmly in position. When this class of brush is temporarily out of use, for example, when not required for use for the next day or two, it should be cleaned and then suspended in raw linseed oil. Many, if not most, painters use water for the purpose, but this is objectionable because it affects the elasticity. Others use turpentine, and this is even more destructive of that important quality. The object of suspending the brush is to avoid

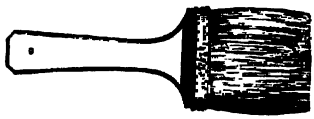

FIG. 15.—Copper Bound Distemper Brush.

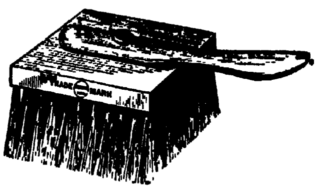

FIG. 16.—Stippling Brush with Reversible Handle.

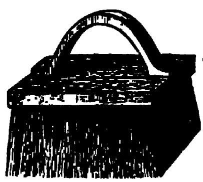

FIG. 17.—Stippler with Bridge Handle.

the twist at the bottom of the bristles which would occur if the brush were unsuspended and which would render it practically useless.

Brushes that are not to be used for some time should be thoroughly cleaned by first rubbing the paint out, then washing in turpentine or better still benzene, which is cheaper and quicker, afterwards giving them a thorough cleansing with warm water and soap. They

should then be placed in a fairly cold place until required for use. A paint brush should not be used in varnish as a general rule.

Varnish brushes, after use, should be scraped on the outside to remove any hardened varnish, and then they should be washed in turpentine, and pressed out between clean paper, not rubbed out, as this would remove some of the paper, and cause them to be dirtied. They should be suspended in raw linseed oil or preferably in varnish of the same quality as that they are to be used in, but not of course spirit varnish, which is not left exposed. Very old hardened brushes may be softened and turned to use if they are

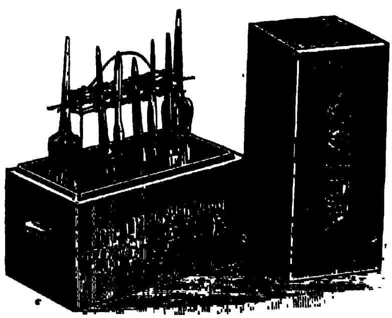

FIG. 18.—The Diving Bell Brush Holder.

soaked for a considerable time in benzene or one of the liquid paint removers referred to elsewhere, or if neither material is available, they should be soaked for twenty-four hours in raw linseed oil, and afterwards in hot turpentine. Stippling brushes should invariably be cleaned immediately after use. They are expensive, and if badly treated they are quite useless for their purpose. The place in which they are stored should not be too dry, and they should be suspended so that the bristles cannot be twisted. A good plan is to use a small box for each, having two cleats to catch the stock of the brushes.

Brush Holders.—As already stated, it is necessary in keeping brushes in good condition, to adopt means to suspend them. There

are various contrivances on the market for this purpose. The "diving bell" is made in two separate forms, one of which is shown in Figure 18. The smaller one carries six brushes and is intended to stand in a paint kettle. Figure 18 is made in various sizes ranging from twelve to thirty brushes, and intended for placing in specially made boxes, which have a cover to keep off dust. This brush holder consists of twists of wire, forming clips which securely hold the brush in position.

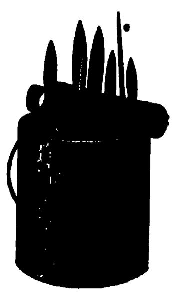

FIG. 19.—The Ridgely Brush Holder.

Another serviceable device of the same character, but a different shape, is the "Ridgely," shown in Figure 19. This is made in two sizes, 9 inches and 18 inches long respectively, and consists of a roll of wire, between which the handles of the brushes are placed.

Paint Strainers.—The necessity for straining paint, so as to take away every particle or speck which would, if allowed to remain, considerably mar the appearance of a painted surface, has already been insisted upon. There are several different forms of paint strainers, the simplest of which is shown in Figure 20. Other forms have the gauze bottom detachable, being kept in place by a band. One of the latest forms, Beaumont's patent refill strainer, is provided with a removable bottom consisting of gauze fastened to a metal rim which fits into the receiver like a lever in. By having a number of gauze bottoms of different mesh the strainers may be made suitable for varnishes and paints of different qualities.

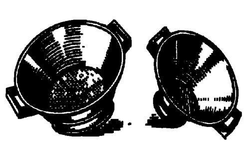

FIG. 20.—Paint Strainers.

Blow Lamps.—Although paint solvents or removers have made such progress in recent years, burning-off lamps are still used to a considerable extent, particularly for outside work. There are many forms, of which one is shown in Figure 21.

The "Easilit" lamp is used for petrol, and has patent warming and starting burners. Both burners are self-cleaning, and no cleaning pin is required. Some decorators prefer a Swedish form of lamp which burns benzoline.

Still another lamp of Swedish origin is made to burn paraffin oil.

Scaffolding and Ladders.—Owing to the fact that the work of painting and decorating usually takes comparatively little time, it is not usual to erect elaborate scaffolding, such as would be necessary when a structure is to be erected. Various forms of extension ladders are employed, or other means adopted to meet the particular case. In Figure 22 we show an ordinary extension ladder which

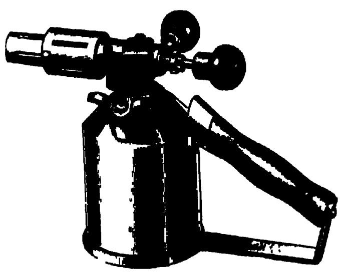

FIG. 21.—The "Easilit" Blow Lamp.

saves a great deal of time in adjusting to the proper position. It will be observed that a ladder can be raised by the simple means of pulling a rope on the ground, thus raising the ladder to any height required. Clutches which move automatically are brought into position, and hold the rung at any place desired.

Figure 23 shows what is known as a painter's window cripple, which is provided for a man to sit down while painting the outside of a window. It is provided with adjustable irons which prevent it getting out of position. A clever and useful invention is named the Kruse Patent Scaffold Wall Cradle, and a general idea may be obtained from Figure 24. It consists of a strongly built but comparatively light framework, which is supported on the rungs of a

ladder by substantial hooks, operated by two handles, one on each side. When the workman wishes to move the cradle either up or

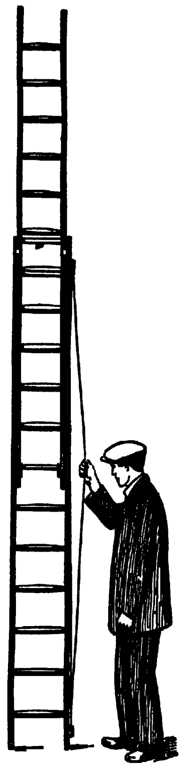

FIG. 22.—Extension Ladder.

down he steps from the platform on to a rung, turns the handles and so lifts the clutches from the rung. He then walks up or down the

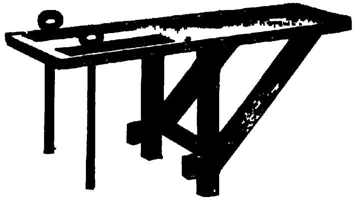

FIG. 23.—Painter's Window Cripple.

ladder in the ordinary way. When he wishes to descend, he allows the handle to turn back and a hook spring forces the clutches again

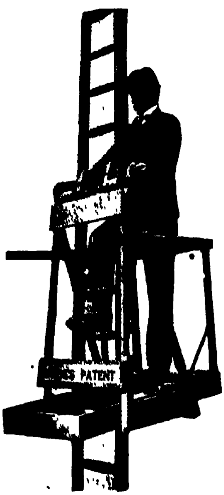

FIG. 24.—Kruse's Wall Cradle.

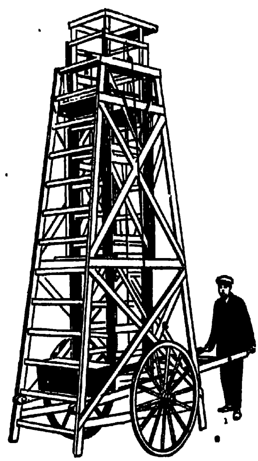

FIG. 25.—Extension Tower Ladder, Closed.

on the rung. The platform is fitted with an extension for use when nearing the ground. The manufacturers are Messrs. Stephens and Carter.

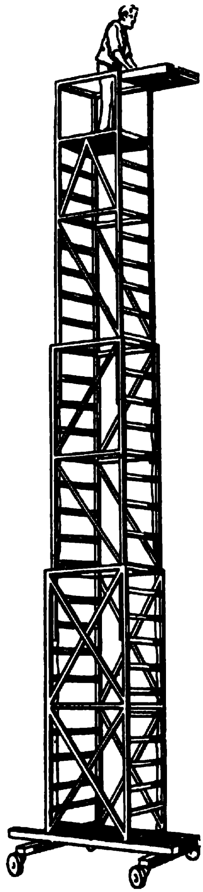

FIG. 26.—Another Tower Extension Ladder, Open.

Perhaps the most useful ladder which can be used for a painter when treating the ceiling of a large open building, such as a town hall, church, etc., is the extension tower ladder which is shown, in two different forms, closed and extended respectively, in Figures 25 and 26. It forms a firm base and can be readily moved from one place to another.

Ladder Brackets.—In order to hold the ends of a plank to ladders special brackets are usually employed. These are of various forms, one of which is shown in Figure 27.

Swing Cradles.—These useful appliances are much employed by painters and save a considerable amount of time and money in

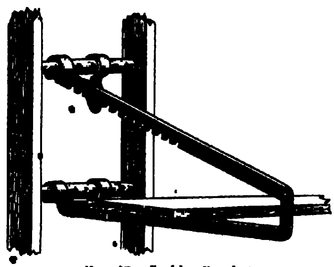

FIG. 27.—Ladder Bracket.

erecting scaffolding from the ground. They consist of a " boat " or platform railed in at front and back, and are suspended by strong ropes or wires from the roof. Pulleys provided enable them to be raised or lowered at will. In the illustration is shown a house in course of being repainted, in which swing cradles are used.

Palmers' Patent Travelling Cradle is a distinct improvement on the ordinary form, as its construction permits of its not only being raised or lowered, but also moved to any point from one side of the front to the other. This is effected by suspending the cradles on a stout wire cable at the top of the building. An ingenious but simple mechanism causes the cradle to move to any position desired.

Of course much painting is done from ordinary ladders, but in

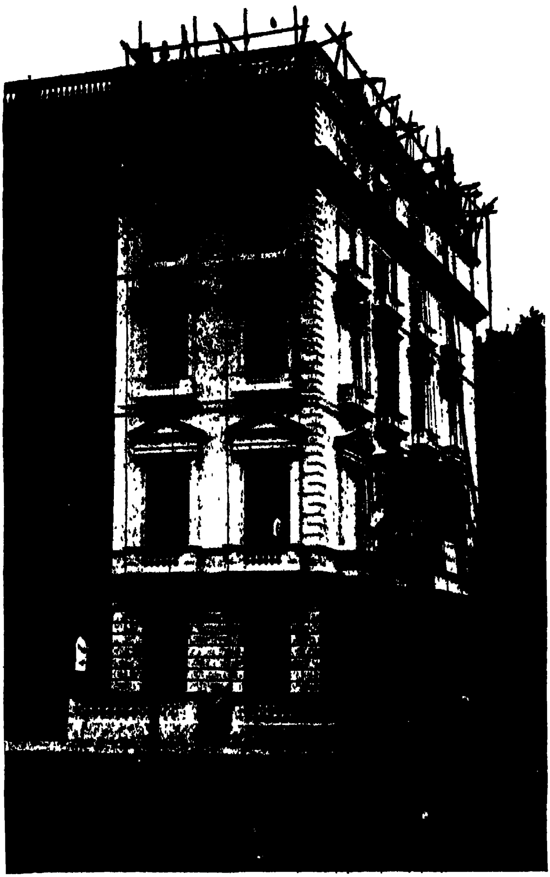

FIG. 28.—Illustrating the Use of Swing Cradles.

FIG. 29.—Scaffolding, Westminster Abbey, by Messrs. Stephens and Carter.

narrow streets and in many other situations the use of cradles is imperative.

Glasspaper.—This is tough paper the surface of which is covered

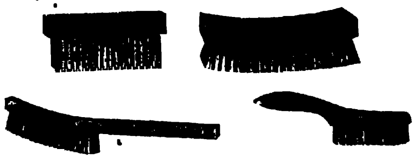

FIG. 30.—Various Forms of Wire Brushes for Cleaning Iron before Repainting.

with finely crushed glass or silica flint. Formerly sand was used for the purpose. Glasspaper bears various numbers, denoting the fineness, O, being very fine, is suitable for delicate work.

Steel Wool. Of late years, glasspaper for rubbing down has to

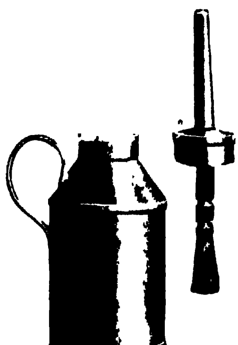

FIG. 31.—Brooke's Knotting Bottle.

some extent been superseded by a material known as steel wool. This is not a waste product, but is specially made for the purpose, and it consists of very fine hair-like lengths of steel which are so

made that when bunched together they possess a sharp edge. Steel wool is used by taking a bunch in the hand and rubbing it over the surface, when it will be found that it smooths quicker than glass-paper and gives a surface free from scratches. It is made in four grades; the finest of them can be used in place of powdered pumice stone and water. Another advantage claimed for the material is that it will reach the interstices of the finer mouldings and any places which it would be almost impossible to reach by means of

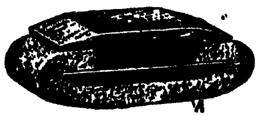

FIG. 32.—Pad for Rubbing Down Painted and Varnish Work.

ordinary glasspaper. If desired a little oil may be used with the finest grade.

When pumice stone and water are used, there is always a certain risk of a little grit being left behind which mars the finished surface. This is impossible where steel wool is used, provided of course that the surface is dusted down on completion.

In many parts of the Continent, notably Holland, the finest grade of steel wool has wholly taken the place of powdered pumice stone and water for rubbing down varnish, and it effects a considerable saving of time. For ordinary painted work glass paper continues to be used.

Paint Mill.—A paint mill is of considerable importance for use in grinding up waste paint, but in modern times it is not so much used as formerly, owing to the increased use of ready prepared paints.

CHAPTER VIII

DEFECTS IN PAINTERS' WORK

HOWEVER carefully painters' materials may be selected for their particular purpose, and however skilfully those materials may be applied by a practical man, unexpected defects will sometimes appear which it is very difficult to account for. To take a simple example, a row of stucco fronted houses were repainted with white lead paint in the late autumn. Exactly the same paint and thinnings were used on all the houses. Within a few days of the completion one of the houses was found to be considerably discoloured (darkened) while the others had not changed. The correct explanation in this case probably was that the painting was done during windy weather, and that the smoke from an adjacent chimney had been blown against the front of one of the houses, when the sulphur contained in it had affected the white lead and caused it to become darkened.

Quite frequently defects arise from some simple matter being overlooked. The most familiar example of this in connection with varnish work is a hall, where it is sometimes found that the wall on one side will be cloudy and "blooming," while the rest of the work done with the same varnish will not be affected. Such an apparent phenomenon is explained by the fact that the hall door was left open during the time the varnish was being applied; the stream of cold air striking against the varnish in the warm hall would be almost certain to produce the unsatisfactory result alluded to.

In other cases, defects in painting may be due of course, to the use of materials, which although good in themselves are unsuited to the purpose for which they are employed. Again, one material may act adversely upon another—as, for instance, ultramarine, if mixed with white lead, will lose its characteristic colour, owing to the

sulphur it contains. In some cases the workmanship is at fault—as for example, when varnish does not dry hard, the assumption is that the work was not thoroughly cleaned; and this is particularly the case when seats in a church or public meeting place are being dealt with. Then, again, paint will sometimes be found to remain soft, even after it has been applied for several weeks. If the surface was thoroughly clean, and the materials composing the paint were of good quality, the true explanation of the trouble would probably be the use of an excess of driers.

Enamels and varnish when applied in cold weather sometimes unaccountably show a lack of gloss. Now these materials are both difficult to apply in cold weather; they pull on the brush, and necessitate the workman using much more force than would be the case in warm weather. With the object of lessening the labour, some workmen surreptitiously add turpentine to the varnish or enamel, and give rise to this defect.

So often are complaints received by the manufacturers of painters' materials that the larger firms almost always employ an expert to inspect and report in great detail upon work which is not turned out satisfactorily. It is suggested that architects should not blame either the workmanship or the material when work "goes wrong," but should communicate with both contractor and manufacturer, and endeavour to get to the seat of the trouble.

The subject is clearly of such importance that considerable space would have been given to it here, but for the fact that a book[1] dealing with the whole subject has recently been issued. We may, however, refer to a few of the more important parts of the subject.

Bleeding of Reds.- This defect is fully described under the heading of "Materials" and "Tests."

Blistering.—Few of the troubles which seem to be inseparable from painters' work are more persistent or more difficult to account for in some cases than blistering of paint. The blisters may arise from—(*a*) Too much or too little oil in some of the coats; (*b*) the

[1] "Paint and Painting Defects, Their Detection, Cause and Cure." by J. Cruickshank-Smith, B.Sc., F.C.S. London Trade Papers Publishing Co., Ltd., 1912.

application of too thick a coat, or what is practically the same thing, too little brushing out; (c) unsuitable conditions of the surface; (d) improper materials used in the paint; (e) locality.

Taking these defects separately, attention may be again called to the desirability of varying the quantity of oil and turpentine in the various coats in order to promote adhesion between them. But this may be over done, and the coats may be too oily or too flat, and hence the proper key would not be given. When blistering occurs from too thick a coat of oily paint, it has probably been put on by an inexperienced workman. It is for this reason that amateurs find their paint so often blistering. In applying all oil paint considerable exertion must be used, and the paint should be put on as though it were very valuable and scarce.

The unsuitable condition of the surface is another important element which causes blistering, even when the paint is of the correct quality and is put on in a workmanlike manner. These conditions may consist of exudation of rosin from the knots or other parts of the wood; or more frequently the blisters occur from moisture in the wood, which has been painted too soon after rain or fog. Under such conditions, the heat draws out the moisture and converts it into steam, which raises the film of paint. When improper materials are used in paint there is a tendency to blister, but it does not blister frequently from this cause.

Locality causing paint blistering means simply that a particular door or other painted work is in a position where it catches the full force of the sun.

The author has found that the best cure for badly blistered work is to take the paint off down to the priming, and then to give two coats of good water paint. This paint when dry cannot blister; it can come off altogether in flakes or otherwise, but any amount of heat or moisture underneath cannot cause it to form blisters. Upon water paint may be put ordinary oil paint, taking care that too much oil is not used.

Blistering of varnish rarely occurs. The blister usually consists of the whole paint film together with the varnish, if any. When varnish does blister, it may be attributed to spots of grease under the varnish. Excessive heat will also cause it.

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Blooming.—This serious defect arises either from moisture which attacks varnish while setting or is contained in the gum from which the varnish is made. It may also arise from impure air contained in the apartment in which the varnish is applied. Blooming appears something like the bloom on a ripe plum, hence the name. It is a somewhat remarkable fact that it is more likely to occur on high-grade varnishes than on the cheaper variety. To avoid blooming it is important that the varnish should be applied in a well-ventilated room of uniform temperature, about 60° F. is the best, and care should be taken that cold air is not admitted until the varnish has set hard. It is also necessary to see that the varnish taken from the store is not much colder or hotter than the room in which it is to be used. Blooming often occurs in damp houses, and in churches in the vicinity of the font or baptistry. To provide a remedy is difficult. Rubbing the surface with a soft cloth dipped in paraffin oil or raw linseed oil, and finally polishing with a soft chamois leather, will sometimes effect a cure, but the blooming is always likely to re-occur, and a second treatment will then be necessary.

Occasionally blooming is caused by ammonia in the air, and in such a case it is due to a chemical change and cannot, therefore, be remedied. Mr. J. C. Smith states that rubbing the surface over with strong acetic acid and afterwards polishing with a clean leather is also sometimes beneficial. In difficult cases the ventilation of the room should always be carefully attended to, particularly if a gas stove is used.

Brunswick Green turning Blue.—Many architects and property owners have deplored the fact that wood and other work painted with Brunswick green has changed after a few months' exposure, becoming almost blue. This change is due to a chemical action between the Prussian blue and chrome yellow of which the green is partly made, and when it occurs there is no remedy.

As a matter of fact, Brunswick greens are rapidly going out of favour, as permanent greens are now to be had in a variety of pleasing shades which cost but little more. Of these, the "Suffield" greens of Messrs. Mander Brothers are strongly to be recommended. Lincoln green and zinc green are also much better than Brunswick green.

Brush Marks.—When the marks of a brush show on the completion of painted work it indicates either an improperly prepared surface which remains absorbent, incompetency in applying the paint, or a defect in the mixing of the paint which is too thick for the job. Cheap brushes containing a large amount of adulteration are also responsible for a good many brush marks. Indeed, it is doubtful whether the best "brush-hand," as an expert in applying paint is called, can altogether avoid these marks if he is compelled to use such a brush. Ordinary paint, distemper and enamels flow out after they are applied and the brush marks quickly disappear. In finishing flat work on a wide expanse, say, for instance, the wall of a large staircase, it is difficult to eliminate brush marks altogether, and it is for this reason that stippling is done on such work. This is dabbing with a special brush called a "stippler," which takes out all brush marks and divides the surface into minute depressions which gives a very soft and pleasing effect when viewed from a distance.

Chalking.—This term is applied to oil paint which loses its original nature and takes a condition like imperfectly bound whitewash. In other words the paint will partly come off on to the hand or a piece of black cloth when rubbed against it. The defect is due in a greater or less degree to the perishing of the oil in the paint, and it is frequently found to occur in white lead paint when exposed to sea air. There is no remedy, but to avoid the same trouble when repainting different paint should be used, and the best in the opinion of the author is either to use for the final coats zinc oxide, or a paint made of white lead and zinc oxide with a small percentage of barytes, which should give a lasting paint and one which will not chalk.

Cissing of Varnish.—This defect may be said to be an exaggerated form of pitting. In other words, the varnish at certain points does not adhere properly, and hence there is no uniformity. If, for example, varnish is applied to a surface which has been painted so as to leave an oily surface there will be more or less difficulty experienced in getting it on. A little whiting rubbed on will often assist in removing this trouble, and the practice is often resorted to in grained work.

Colours, Fading of.—When colour fades it is usually due to free lime in plaster, such as in the case of distempers and water-paints, or it may occur from the colours being naturally fugitive. On another page will be found a complete list of colours which are permanent, and those which are more or less fugitive, and also those which are susceptible to certain fumes and affected by free lime.

Cracking of Varnish.—This is the same defect as crazing, but is of a more extensive character.

Crawling.—Three general reasons may be given for this defect:—(a) Insufficient adhesion between the varnish and the surface to which it is applied; (b) The varnish being too thick or viscous; (c) The varnish being applied too liberally, as might very easily happen in cold weather. When crawling occurs from either of these causes there is no remedy except removing the old coat and revarnishing.

Crazing of Varnish.—This defect consists of minute intersecting cracks which appear over the surface, and it is usually due to using a hard varnish over an elastic one. It may also be due to an inherent fault in the varnish itself, owing to the excessive use of hard gums, but inasmuch as these gums are expensive and hard to melt the defect rarely arises from this cause. Extreme cold will sometimes cause varnish to craze.

Damp Walls.—The cure for damp walls is frequently outside the scope of the decorator, being a matter for the builder. For example, when a wall is damp owing to surface water coming through or when it forms part of a basement, a cure depends upon building a second wall to separate the main wall from the soil. Sometimes dampness of a wall arises from want of a damp-course, but this is only found in old buildings or those situated in the country. The building laws of most cities require the insertion of a damp-course in every case of a newly erected structure. If one must be inserted this can be done by shoring up the building and putting in lead, slate or cement, say 18 inches to 2 feet at the time.

Sometimes rain will be found to drive through a wall. In other cases unsound bricks may here and there lead to trouble. The old method of coating a wall with lead foil may now be regarded as

practically obsolete, as much better results may be obtained by using one of the various specialities which are sold for the purpose. In cases of extreme difficulty the following method is recommended, having been used on several occasions by the author when dealing with half basement houses. Having tried a number of specialities, the difficulty was always reached of getting the wall dry or nearly so before the material was applied. Large fires were made in the various rooms contained in "devils," but even then the walls still remained damp. Under these circumstances the whole of the plaster on the walls was stripped off and the work was replastered with Portland cement to which a little sand had been added. This proved quite effectual, as, of course, the cement will settle in the presence of moisture, in fact, it is necessary for it to become hard. Sometimes the dampness arises from sea sand containing salt being used in the mortar. In this case it is impossible to withdraw the salt and the best way is to treat the wall with Portland cement. The following are some of the mixtures recommended by various authors:—

(1) Two coats of petrifying liquid.

(2) Coat the wall on the outside with a mixture of linseed oil, rosin and tallow or beeswax.

(3) Dissolve 6 lbs. of chloride of calcium in 2 gallons of soft water, settle and drain. Reduce in a separate vessel 1 gallon of concentrated silicate of soda or water glass with 1 gallon of hot water. Mix well and strain. When using the liquid on old walls all the paper, whitewash, or loose plaster must be removed. Apply the chloride of calcium mixture and immediately afterwards the silicate of soda solution. If not dry within two or three hours, follow with a second coat of the water glass. Unless the chloride of calcium is employed the latter will be useless.

(4) The *Painters' Magazine* gives the following: 50 lbs. air slaked lime, 10 lbs. glucose, 2½ lbs. powdered alum, 2 gallons boiled linseed oil, 5 pints oil of eucalyptus, are placed in a small barrel or tub, and 8 gallons of warm water gradually added, stirring in the meantime until all is dissolved. If this liquid is too stout to work freely, more warm water is added. Any lime-proof pigments, such as zinc oxide, oxide of iron reds, ochres, umbers, lime

blue, etc., may be mixed with the liquid and applied on the inside of such walls as those mentioned, but at least two coats are required to obtain the desired result. From 3 to 4 lbs. of pigment are required to the gallon of liquid, excepting in the case of umber or lime blue, where 1 and 1¼ to 2 lbs. is ample. If this damp-resisting paint does not give the result looked for the remedy must be applied from the outside of the wall.

(5) The following is said to be a good application for damp walls:—Dissolve ¾ lb. of mottled soap in 1 gallon of water. This composition is to be laid over the brickwork steadily and carefully with a large thick brush, but not in such a manner as to form a froth or lather on the surface. It must be allowed twenty-four hours to dry on the walls. Now mix ½ lb. of alum with 4 gallons of water; let it stand twenty-four hours, and then apply it over the coating of soap.

The operation must be performed in dry weather.

(6) Another method is to use 8 parts linseed oil and 1 part sulphur, heated together to 278° F. in an iron vessel.

Another Waterproof Coating.—Rosin oil 50 parts, rosin 30 parts, white soap 9 parts. Apply hot on the surfaces to be protected.

Dissolve in 4 gallons of warm water, 1 cwt. of slaked lime, 7 lbs. of sugar and 1½ lbs. of alum. Add 1 gallon of boiled oil, 2 pints of eucalyptus. More water may be added as may be necessary.

The following are a few waterproof paints suitable for application to damp walls, but there are many others to be had:—

Inertol is described as a waterproof preservative paint which is useful for protection against dampness, acids, alkalies, salt water, etc., and may be used on iron, cement or concrete surfaces.

Melena is an enamel paint prepared in twenty-four colours and intended for use on damp walls. When dry it can be washed. On new work two coats are required, the second being applied after the first is thoroughly dry. The surface to be enamelled must be free from grease and dirt. The second use for this material is as a coating on new plaster which it is desired to cover with wall paper. Two coats would effectually prevent any discoloration of the pattern.

Pinchin's N.D.K. Stone Fluid is a transparent liquid which is brushed on like paint. Its action is claimed to be that of thoroughly

waterproofing the outside walls by forming an inert film through which water, moisture, or any form of dampness cannot penetrate. It may be used successfully to prevent stone decaying.

Ironite.—Ironite is supplied in the form of a fine mineral powder packed in metal cans. It is mixed with water to about the consistency of ordinary whitewash and spread upon the desired surface with a brush. It is particularly suitable for application to concrete, brickwork, etc., and is strongly recommended for application to damp walls.

Rubberose.—This speciality is used for coating outside brick or stone, but it is also largely used on newly plastered walls, or on those which have been patched, so as to permit papering to be done without the risk of the colours fading. One gallon covers about 90 square yards, and two coats should be given.

Deadening.—This term is applied to varnish which loses its gloss, and the defect is generally due to an absorbent undercoat or imperfect filling of the wood, especially if it is hardwood, such as oak. Unseasoned timber is particularly apt to cause deadening of the varnish applied to it.

Efflorescence on Brick and Stone Work.—Not infrequently new buildings are greatly disfigured by a white incrustation or efflorescence which appears on the surface soon after they are completed. The same trouble is not infrequently noticed on old buildings, particularly after a very heavy rain of long duration. The efflorescence appears in the shape of a light powdery crystalline substance, which in many cases is a form of sulphate of magnesia or impure Epsom salts. It may appear on the bricks, on stone, on the mortar joints, or on both. It arises from certain soluble salts contained in the clay from which the bricks are made, in the stone or in the lime from which the mortar is made. It is difficult to eliminate the soluble salts when they exist, but washing the clay previous to making the bricks is sometimes resorted to. In cases where the efflorescence does exist the surface should be first well brushed down. Then a solution of soap, made by dissolving 2 lbs. of soap to a gallon of water, should be given, and when dry this should be followed by a coat of alum in solution, say 1 lb. of alum to a gallon of water, or aluminium sulphate may be used instead of alum if desired.

Another remedy sometimes used with good effect is to wash down the surface with a solution of hydrochloric acid.

Efflorescence sometimes appears also on newly plastered walls and arises from uncombined salts in the lime. In such cases a weak solution of acetic acid should be applied.

Flashing of Paint.- This term alludes to two entirely different effects :—(a) The occurrence in flat work of glossy patches ; and (b) exactly the reverse, viz., the appearance of dull or flat patches on paint work finished glossy.

In the former case the flashes may be due to want of uniformity in the under coats, to the use of turpentine substitutes, which are particularly prone to give rise to flashing, particularly if the work is done in very hot weather. When dull patches occur on oil paint the work requires another coat of paint all over, but if this cannot be given owing to the expense, a soft rag dipped in linseed oil rubbed over the dull places will produce a fairly good result.

Mildew.—Imperfectly seasoned timber, together with dampness in other local conditions, sometimes gives rise to a fungus appearing on the surface of painted woodwork. The term "mildew" is usually applied to this defect, which is not only very unsightly but under favourable conditions the fungus will spread and completely destroy the paint film. Doubtless the linseed oil, being of vegetable origin, feeds the fungus to a considerable extent. The remedy is to first brush and afterwards rub down the painted surface very thoroughly and then to give a liberal coat of genuine American turpentine, which appears to destroy the growth. A good washing with strong soap is another method recommended. Five per cent. of benzene added to the turpentine is said to be an advantage.

Paint Peeling.—When this defect occurs, it of course is evident that there is not sufficient adherence between the paint and the surface to which it is applied. The commonest causes are :—(1) Damp wood ; (2) Dampness back of the wood ; (3) Ochre priming coat ; (4) Loose old paint not thoroughly cleaned away ; (5) Resinous wood not properly seasoned or prepared for painting ; and (6) Boiled oil in the priming coat.

Wood may be damp for many other reasons than imperfect seasoning. For example, its pores being open it will absorb moisture

very readily, hence dew, fog and rain are alike apt to render the wood unsuitable for painting for the time being. If paint is applied to such a surface, heat will drive the moisture out and cause the paint to peel. Plaster if painted upon before it is quite dry is almost certain to cause peeling either of the oil paint, distemper or washable water paint which may be applied to it, unless some special preparation is given to prevent it. In the case of some of the "patent" plasters the peeling may arise from exactly the opposite cause, viz., the painting is left too long, until the plaster sets with a glass-like surface which gives no key. A coat of sharp paint applied while the plaster is wet, as mentioned on another page, avoids the trouble by giving a "paintable" surface.

Ochre is so rarely used in this country as a primer that it will be sufficient to state that it is wholly unsuitable for the purpose. When paint peels owing to an insecure foundation, such as loose paint, it clearly indicates slovenly work. In cases where a painted surface shows signs of coming away from the wood it is often cheapest in the end to remove it altogether and start afresh, but where the expense as, for instance, where the surface to be repainted is of considerable extent will not permit of this, a thorough sandpapering and rubbing down with wire brushes will usually produce a surface which will answer its purpose. If still rough, steel wool may be employed, but at the best the work under such conditions will be but a make-shift.

When paint peels from a resinous exudation from the wood, more turpentine than usual should be used both in the priming and the second coat. Rosin and turpentine are of course closely allied in nature, being both derived from the same source, *i.e.*, crude turpentine, exuding from certain pine trees which yield on distillation turpentine proper, the substance left in the still being ordinary rosin, which is afterwards refined in a manner depending upon the purpose for which it is to be used. Boiled oil should not be used in a priming coat because it has a tendency to give too glossy a surface—exactly what is *not* wanted.

Pitting and Pinholing. There are several causes to which may be assigned this defect. It appears in the shape of small dull places like pinheads on the surface of varnished work. Turpentine, if

left in a brush after cleaning, will sometimes cause it; and an unclean surface upon which there is dirt, grease, or soap, as well as frothy varnish, will also cause the trouble. Usually the defect may be avoided by thoroughly rubbing down the surface before the varnish is applied.

Powdering or Flouring.—Under certain conditions varnish loses its gloss and becomes reduced to a powdery or floury condition. This will often occur when a varnish intended for inside use is used outside. In any case where it occurs it points to an incorrect selection of the particular grade of varnish used, and there is no remedy.

Putty Staining.—Sometimes putty is found to give a nasty stain on white woodwork or enamel which is applied over it. This is due to impure oil being used, and can never occur in properly made putty, which should consist of pure linseed oil and whiting only.

Seedy Varnish.—Sometimes after varnish is applied it may be found to have a peculiar appearance, as though it contained minute seeds. This is in most cases due to the varnish having been stored in a warm place and immediately applied to a cold surface, or *vice versa*. The remedy is to bring the varnish as nearly as possible to the temperature of the room in which it is to be used.

Shortness of White Lead.—This is a defect which indicates that either the lead is too new or that it is ground in an insufficient quantity of oil. Adulteration will also produce the same result. The lead, instead of clinging together like good putty does, breaks off short and shows a tendency to crumble. It may be mentioned here that the stiffness of white lead varies considerably according to the locality in which it is to be used, according to the particular requirements of painters in different parts of the country. In Scotland and the North of England generally a thin lead is preferred; in the Midland counties, one of medium stiffness; and in London and the South a stiff lead is almost invariably preferred.

Smoke Stains.—When work such as a ceiling is badly stained by smoke it is not sufficient to merely wash it off with clean water, as is often the custom. Such stains consist chiefly of carbon and are more or less of a greasy nature, and also contain a certain

amount of free sulphuric acid. The washing should be done very thoroughly, and then the surface be washed with a coat of dilute acetic acid, which will kill the acidity. When dry the surface should be given a coat of bleached shellac varnish, or if the case is a very bad one, two coats should be applied. Upon this a coat of flat white paint should be applied, and this will form an excellent foundation for distemper, which can then be uniformly applied without difficulty.

Specks or Nibs.—On very closely examining a varnished surface it will frequently be found that the work is much marred by small specks, which appear at intervals all over the work and greatly detract from the finished appearance. These may arise from dirty brushes or even from dirt in the varnish, but much more frequently they are caused by the minute particles which are suspended in the air. Some varnishers on this account put water on the floor before commencing to apply the varnish, but here the remedy may prove more disastrous than the disease because the moisture may affect the varnish seriously. In painting carriages, where the surface is required absolutely free from specks, special varnishing rooms are provided in some cases. These are ventilated on a scientific basis, and the precaution is even taken of admitting air through double gratings filled with cotton wool. The workmen have to take special care of their personal cleanliness, even of their clothes and hair, beard, etc., and the brushes are cleaned with scrupulous care. In the ordinary house painter's work these conditions are, of course, impracticable, and the only thing to be done when varnishing is to allow the room to rest for some time before the varnish is actually applied, and then if any nibs appear, carefully pick them out with a sharp pointed piece of wood immediately after the varnish is applied, and before it has commenced to set.

Spotting.—Sometimes spots appear on a varnished surface. These may be due to spots of some kind on the wood or other material before the varnish was applied but they are more frequently caused by cold air. If the spots are due to splashes of mud, as, for instance, in the case of carriages, they can be removed by washing with rainwater and drying in the sun.

Sweating.—This is a term applied to a varnish which has been

rubbed or felted down, and is due to the rubbing varnish having been applied before the under coat was sufficiently hard. Sometimes the defect is called "flashing." The term "sweating" is also applied to French polish work when small drops appear on the surface. This is due, according to Mr. J. C. Smith, to an excess of oil beneath the polish, but Mr. Charles Harrison attributes it to the small amount of petroleum which is contained in commercial methylated spirits, and which is added under the Government regulations: this spirit being sometimes used for final preparation in French polishing, or spiriting off. Pure alcohol is much preferred for this purpose.

Tacky Varnish.—This term is used to describe a varnished surface which does not dry hard, but remains sticky. The cause is usually a dirty or greasy surface, but it often arises from the lack of pure air, which, if supplied, would give the oxygen necessary for the proper hardening of the varnish.

White Lead, Discoloration of.—Those who have studied the subject, even superficially, know that one of the properties of white lead is that it darkens when exposed to sulphur fumes, this being due to the formation of sulphide of lead. Sulphur is contained, of course, to a small extent in the air of all large towns in which soft coal is burned, and in passing it may be mentioned that gas manufacturers are giving as one of the reasons why gas should be used in preference to coal, the fact that it does not give off so much sulphur. In most American cities anthracite coal is used. This is practically smokeless and gives off little or no sulphur, hence the American tests with painter's materials may be looked upon with suspicion, because the conditions in the two countries are so different. When white lead has once become discoloured it cannot be restored to its original colour. A preventive measure may, however, be taken by either using a pigment such as zinc oxide, which will not be affected in the same way, or if lead is preferred the finish may be zinc oxide with or without copal varnish added to it, or a coat of good varnish will wholly prevent the trouble.

Whitening of Varnish.—This unsightly effect is, as a rule, due to the absorption of moisture. When a varnish is to be used in a position where there is much water, say, for example, on a

boat, at the seaside, or in damp situations generally, a special grade of varnish made from extra hard gums should be used. The causes which give rise to "blooming" (*q.v.*) to some extent give rise to whitening also. As explained under the head of "Testing Painters' Materials," a simple method of testing varnishes is to apply a sponge or pad saturated with water to the hard film and leave it for twenty-four hours, and a white mark will often be found where the water is brought in contact. In some varnishes this mark will disappear after a short time, in which case the varnish may be safely used; but if it remains permanently it indicates the presence of rosin, and the varnish should be rejected. If spirits such as whisky, brandy, etc., come in contact with varnish, they will in most cases cause the surface to become white, but this disappears after a time. For table tops, counters, etc., upon which to set spirit glasses, special hard polishing varnish should be used, and this will not turn white at all.

CHAPTER IX

SPECIFICATIONS FOR PAINTERS' AND DECORATORS' WORK

The following suggestions are intended for the use of engineers, architects, and others to regulate the labour and material in all the principal kinds of painting. They are in some cases more elaborate and lengthy than would be needed for ordinary work, but adopted as a whole they will be found useful for those who have to purchase in large quantities, as, for example, a railway company or corporation.

If one takes an ordinary architect's specification it will be found that the clauses relating to painting are usually most unsatisfactory. Wood and other work is specified to be finished in "four oils," which means little or nothing. Then quite frequently one finds that all the materials are specified to be the "very best of their respective classes," which, in the case of certain buildings of minor importance, is an absurdity. Take varnish for example. The clause quoted would literally mean a varnish costing perhaps 30s. a gallon. If the property to be painted consisted of cottages, or small villas, one would not dream of using so expensive a product.

A point to which particular attention may be attracted is the custom of specifying a certain brand of lead, oil, varnish, water-paint, or other material. It is quite reasonable and natural that an architect or property owner who has used a certain brand of varnish which he finds gave good results should wish the same kind to be employed in his new work. The custom, however, is sometimes rather unsatisfactory to the decorator, because the particular brand specified may be made by a firm with which he has not had previous dealings, and he would, therefore, probably have to pay a higher price for a small quantity of the material required than he would if he purchased through his ordinary mer-

chants or manufacturers with whom he did business regularly. A more important point, however, is that his workmen might not be acquainted with the peculiar nature of the specified material, for it may be taken as an established fact that all painters' materials have their peculiarities. To some extent, this accounts for the fact which has often been noted, that working painters who are called upon to apply a material which they are not accustomed to would often condemn it because it works differently to what they have been using. For example, white lead being really a lead soap, is easy of application. Certain other pigments are not quite so easy, although they may, as a fact, possess considerable advantages from the point of view of their durability.

Perhaps the best plan to follow when specifying goods of certain brands is to insert a saving clause to read "or other approved material of equal quality." The contractor can then ask permission to use any particular material in place of that specifically mentioned, and would hardly be likely to do so unless he were convinced that good results would ensue. Certainly the architect would not give his consent unless he were equally convinced.

In drawing up a specification the writer should endeavour to make his wishes as to what is required as clear as possible. Indeed a well-drawn specification can leave no doubt whatever on the subject. It should be remembered that however carefully and minutely a specification may be drawn, its terms can be evaded if the contractor wishes, and this is particularly the case with painters' work. However stringent and thorough the supervision exercised may be, the actual materials used depend largely upon the honesty of the contractor. It is partly for this reason that tenders vary so largely. Sometimes the difference between the highest and the lowest is as much as 100 per cent. In such a case the explanation is probably that the highest bidder interprets the specification literally, and because material and labour are specified to be the best of their several kinds, he makes his calculations on that basis. If the master painter has done work for the same architect or owner on some previous occasion he will be better able to judge as to what will be actually insisted upon, and will know how far the letter of the specification is to be followed. For

this reason it is found most satisfactory not to change the contractor on different jobs often. Having obtained a satisfactory job from a master painter at a reasonable price he should be given further work and be told exactly what is wanted, it being left to him to produce the required results in his own way.

In some cases where a large amount of the same paint is required and it is of a special composition, the best plan is to arrange that the order be given by the contractor to a manufacturer who supplies it in quantities as required, and who guarantees this composition. In order that it may be seen that the manufacturer lives up to his contract an occasional taking of samples and analysis may be followed in important work.

A clause is usually inserted in specifications to the effect that "all work necessary to completely finish the building, whether specially mentioned or not, is to be included in the tender." This sometimes leads to trouble, because it may become a question as to whether a particular piece of work is or is not necessary. In connection with the carcass of the building, this misunderstanding would not be likely to occur to so great an extent, but in painting, which is after all only a superficial finish, the case is different. Take a simple example: If the specification states that "all ceilings are to be claircolled and whitened," and no special mention is made of the soffits of staircase, yet these would be included because they would never be left plain. In passing it may be suggested that the phrase used might be "all plaster work except where otherwise mentioned shall be claircolled and whitened." On the other hand, if it were intended that the cornice should be tinted, and there was no mention of it in the specification, it should not be insisted upon, except as an extra. In submitting an estimate for tender for painters' work it is sometimes desirable to add words to the following effect, "the items of work mentioned below are included in this estimate (or tender) although not particularly mentioned in the specification." This will indicate exactly how far the estimate goes, and a note of this kind will usually be much appreciated by the architect or house owner.

An interesting point in connection with specifications is the best course to be adopted by the contractor when certain materials

are included, or special methods of work are instructed to be followed which the contractor as a trained and experienced man knows cannot give satisfactory results. If he points out the error, it may be thought that he is actuated by the possibility of gaining some personal advantage. If he strictly follows the specification, he may know quite well that the results will be most objectionable, and he will get the blame. Many decorators under such trying circumstances would proceed to do the work in their own way and say nothing about the variation they had made; but when the architect is "approachable" the difficulty should be pointed out and an opportunity given him of making a change in the clauses.

In dealing both with new work and old it is necessary that arrangements be made so that there is no interference by one set of tradesmen with another. A great deal of trouble and dissatisfaction are the result of this important point being overlooked. Perhaps the electric light or bell operators are the biggest sinners in this respect, for if care is not taken that their work is completed before the decorators start, some dirty marks are sure to appear on the walls, which may mean repainting or repapering.

Again, finished rooms are sometimes used by the workmen in which to take their meals, or to store their clothes. This should be forbidden; indeed, the only safe rule is to arrange matters in such a way that when once an apartment is given into the hands of the painters no one shall be allowed to enter excepting those duly authorised.

In repainting a large house a definite system should be followed in the execution of the work in order to economise in time and to produce satisfactory results. These details will usually be left to the foreman, although in a large building the duty may devolve upon the clerk of the works. It may be also remarked that it is very necessary that the foreman be well acquainted with the specification in all its details; indeed, he should almost learn it by heart.

All dirt should be taken out of the building as soon as practicable, and the work is best commenced at the top of the house, so that by working toward the bottom of the building, all the dirt and rubbish can be easily carted away. In old houses it is very necessary to see that the chimneys are swept before the painters' work com

mences. This may appear to be only a small item, but foul chimneys left unattended to frequently give a great deal of trouble.

Another small point we have to mention is to provide in the specification for an amply sufficient quantity of dust-sheets for the protection of furniture, etc., during the execution of the work, and to replace all articles which have to be moved for the execution of the work.

Contracts.

A contract should, of course, be appended to the specification of all important work.

Two very well-considered and equitable forms of contract for painters' work are issued by the Incorporated Institute of British Decorators (Painters' Hall, Little Trinity Lane, E.C., price 6*d.* each). They are printed on foolscap paper, ready for signing when the blanks have been filled in. Space will not permit of the whole of the text being printed here, but the principal provisions may be given. No. 1 form is intended for use when an architect is employed, No. 2 form when the services of the architect are dispensed with. The following are the chief conditions :—

1. The work to be executed and completed in the best manner and with the best materials.

2. The work to be done to the "reasonable satisfaction of the architect."

3. The contractor to supply everything necessary to the proper execution of the work, whether the same may or may not be particularly described in the specification, provided that the same is reasonably to be inferred therefrom. The employer shall provide water, light and fire, if and as necessary.

4. Vouchers to be provided if required to prove materials supplied are such as are specified.

5. Competent foremen are to be constantly on the work. The architect may dismiss any person who will in his opinion be incompetent, or who misconducts himself.

6. All extras or variations to be authorised by the architect and paid or allowed for at proportionate rates. The measurements of the work to be made by a surveyor mutually agreed upon.

7. Defects in work occurring within three months of the completion of the work which arise either from material or workmanship which in the opinion of the architect is not in accordance with the specification, are to be made good at the cost of contractor unless the architect shall decide that he ought to be paid for same.

8. The progress of the work of the painter is not to be interfered with by other workmen.

9. The contractor is to be responsible for any accident which may arise in connection with the execution of the work.

10. The employer is to remove within forty-eight hours any furniture or effects which the contractor may indicate in writing is likely to be injured.

11. The employer is to take the risk of fire, and in the event of one occurring, contractor is to be paid for work actually done and material delivered.

12. The work is to be completely finished by a given time, and a stated sum is to be paid by the contractor for every day exceeding that time.

13. The time is to be reasonably extended in case of strikes or delay on the part of other workmen, but written notice is to be given when such delay occurs.

14. When the prime cost of materials is given in the specification, it means (except in the case of paperhangings) the sum paid to the manufacturer or merchant after deducting all trade discounts, but not discount for cash. The prime cost of the paperhangings is to be taken at the prices marked on the samples.

15. The work is to paid for in instalments at the rate of 75 per cent. of work actually done, according to the architect's certificate. Such amount is to be paid within seven days. If not paid by the employer within the time agreed upon, 5 per cent. interest per annum is to be paid on the unpaid certificate.

16. If the works are stopped for a given time by the architect or court of law the contractor may determine the contract in writing, and shall be paid for work done at a proportionate scale.

17. An arbitrator mutually agreed upon is to be appointed to settle all differences, if any.

SUGGESTED SPECIFICATIONS.

It will be understood that in writing a specification from the suggested clauses which follow any part or parts may be adopted or passed over according to circumstances. Obviously it is impossible to draw a specification which will meet all conditions.

SPECIAL CLAUSES.

Labour.—The workmen employed in the execution of the whole of the work herein specified are to be skilled men of experience, and are to receive the minimum wage equal to the union rate of . Labourers and lads may be employed as helpers in the proportion of .

Locks, etc.—All locks, sash fasteners, and similar fittings are to be removed previous to commencing work, to be re-lacquered (? painted) and fixed on its completion.

Tints.—Tints of all paint, enamel, distemper and other work are to be painted on small boards and submitted to the architect for approval in the respective rooms in which they are to be used.

Scaffolding.—The contractor is to provide all necessary scaffolding, and to place it as far as it is practicable in the room or position in which it is to be used.

Dust Sheets.—In the case of the decoration of furnished houses ample dust sheets are to be provided for the protection of furniture.

Varnish, Enamel and Proprietary Paints, etc.—All such goods are to be used as received from the manufacturers unless special directions are given for admixture with water or otherwise, and in such cases the directions are to be strictly adhered to.

Materials.—All materials are to be the best of their several kinds, as herein specified. In cases where it is deemed necessary to have an analysis made, or an expert report from a paint technologist, on any material used, the architect may take samples and submit them to an expert, whose report shall be binding. If the report is favourable, the employer shall pay its cost, but if the contrary, the contractor shall pay the expense involved. In the latter case, all material condemned shall be immediately removed from the premises.

Zinc Grey.—All zinc grey is to be the product of the combustion of spelter, and is to contain not more than 75 per cent. of metallic zinc. The use of a mixture of white pigment with black will not be allowed.

Knotting. All knotting is to be pure orange shellac dissolved in methylated spirits, and is to be free from rosin and naphtha.

Special Paints.—The paint used on the following work (fill in details) is to be paint purchased either from the manufacturers or merchants and to be guaranteed by either that it is not stale.

Specification of Painters' Work.—Before giving suggestions for specifications to regulate the execution of some of the most important work it may be pointed out that the details are given at considerable length under the head of "The Paint most suitable for Different Surfaces," and reference should be made thereto.

New Woodwork—Outside.—The woodwork is to receive a coat of priming, composed of white lead mixed with not more than 5 per cent. of red lead and raw linseed oil with turpentine. Boiled oil to be used for all other coats on all outside woodwork. Should there be any sappy parts of the wood, these together with all knots are to be covered with best knotting. If there are any large or loose knots they are to be cut out and the spaces neatly filled in with wood.

All nail-holes, open joints and other imperfections are to be stopped with hard stopping, consisting of 25 per cent. of dry white lead, mixed with ordinary putty; three (or four) coats of paint as herein specified are then to be applied, but the outside painting work is to be suspended in wet or foggy weather and for days thereafter. The backs of all doors and window frames are to receive a priming coat of paint before being set in position.

Old Work.—Note.—If the paint work is in a bad condition, *i.e.*, cracked or blistered, it will be necessary to remove it before repainting, but if it is in a fairly good condition, it may be rubbed down to a level surface by means of powdered pumice stone and moistened felt, or fine glass-paper. The latter, however, is objectionable, inasmuch as it creates dust that will be injurious to the workman if the old paint be made of lead. A careful inspection of the work

will enable the architect to readily determine which part of the paint is to be removed, and he will specify accordingly.

Removal of Paint.– All the following painted work (give it in detail) is to be removed by burning off on the outside of the building, and by the use of paint solvent on the inside. The paint remover must not contain alkali, and the surface of the work is to be perfectly clean after the removal of the paint, so as to be suitable for receiving next coat of paint.

Inside woodwork.—This is to receive three (or four) coats of paint mixed in the same manner as specified for outside, excepting that no boiled oil is to be used (or) priming as specified for outside work (omitting the boiled oil): the work is then to receive two coats of lithopone thinned to the proper consistency, and a finishing coat of zinc oxide (or)

The paint is to be composed of genuine white lead thinned with pure linseed oil (half boiled and half raw) and genuine American turpentine in the proper proportions to produce the best result (or) two-thirds lead and one-third zinc oxide thoroughly ground together in linseed oil or special paint.

Varnished Work.—The following work (give details) is to have a final coat of varnish, the coat of paint immediately under it being finished flat, and to be previously rubbed down with finely powdered pumice stone applied with moistened felt or felt rubber. Before the varnish is applied the surface must be thoroughly washed down to remove the pumice. *Note.*—Sometimes two coats of varnish are given, in which case the first coat should be rubbed down in the manner as above mentioned (or with fine steel wool) before the second coat of varnish is applied.

Plaster—Inside.—Make good all defects with Keen's cement, sandpaper, and give one coat of sulphate of zinc. After twenty-four hours apply three coats of paint, colour to be approved, the first coat to be white lead, second coat 25 per cent. of zinc oxide and 75 per cent. of white lead, and in the last coat 50 per cent. of each.

Plaster—Distempering.—On all new plaster (or on old patched work) give a coat of zinc sulphate, and at the expiration of twenty-four hours one coat of oil paint containing a suitable quantity

of oil, but little turpentine. When dry, distemper with full coat (or coats) of approved colour.

Plaster—Washable Water Paint and Distemper.- This work is to be done in the same manner as described under the head of "Plaster—Distempering," and a second coat of the washable water paint is to be given if necessary.

Pine Floors—Plain.—Make good all imperfections. Give one coat of bleached knotting and two coats of floor varnish, taking care that each coat is thoroughly dry before another is applied.

Staining.- Apply two coats of linseed oil and turpentine--three-fourths of the former to one-fourth of the latter- then make good imperfections, and give a coat of stain of an approved colour added to 2 parts of linseed oil and 3 parts of turpentine, well brushed into the wood. When dry, give a coat ot special floor varnish, manufactured by . (? Rub down lightly with powdered pumice stone and water to give a dull finish.)

Hardwood Floors, such as Oak.--All work to be cleaned and freed from imperfections. Hardwood filler of approved colour is then to be applied, and well worked into the pores of the wood. Two coats of special floor varnish are then to be given. (? Rub to a dull finish.)

French Polishing.—The following woodwork is to be skilfully French polished in the best manner (give all items).

Staining Exterior Work.—The following work is to be stained to approved colour with oil stain, two coats, and afterwards varnished with one coat of special varnish supplied for the purpose (or to be stained to an appropriate colour), with suitable stain added to 2 parts of 160° Benzene to 3 parts of raw linseed oil. When dry, make good all imperfections and give one coat of raw linseed oil mixed with 10 per cent. of American turpentine.

Old Work.—Re-stain the following work (give in detail) with one coat of pure stain prepared as mentioned under the head of "Staining Exterior Work" (or give one coat of raw linseed oil and turps in the proportions above mentioned and stain on top).

Exterior Plaster, Stucco, Cement, and Concrete.—As far as is practicable this work should be done after a period of dry weather.

The surface is first to receive one coat of sulphate of zinc (white vitriol) dissolved in water in equal proportions of each by weight. All cracks and imperfections are then to be filled up with Portland cement. When the patches have set hard the whole of the surface is to receive a second coat of a solution of sulphate of zinc. After twenty-four hours three coats of good oil paint composed of 7 parts of white lead to 3 parts of zinc oxide, ground together to a stiff paste in linseed oil. This is to be thinned with 4 parts of linseed oil to 1 part of turpentine, and 1 pint of good mixing varnish to each gallon of paint, a little liquid driers of first-class quality being also added. A larger proportion of oil and less of turpentine is to be used in the finishing coat.

Brickwork. The following brickwork is to be painted with two coats of paint made of 4 parts of Venetian red to 1 part of white lead. The mortar joints are first to be raked out, and a full coat of paint to be applied very liberally. The joints and all inequalities are then to be brought to a level surface with hard stopping, after which a second coat is to be applied. The last coat is to be Messrs. brick colour of approved shade. At the completion, the joints are to be carefully ruled in at equal distances apart, the vertical joints to be made to represent Flemish bond. The colour of the joints is to be (black, red, white).

Duresco.—The following specifications are added for this well-known material, which was the first water paint on the market when brought out forty years ago.

1. *On New Interior Walls.* Remove efflorescence, if any, and coat the walls once with white Duresco mixed with Silicate Petrifying Liquid, touch up, and when dry coat twice (or three times) with Duresco of tint (the last coat to be stippled), same to be mixed and applied in accordance with the printed directions on the packages.

2. *On New Interior Walls.* (When only two coats in all are specified.) Coat the walls twice with Duresco (tint) mixed with Silicate Petrifying Liquid as stout as it can be applied, touch up after first coat is dry all parts that appear sunk in, in accordance with the printed directions on the packages. Stipple the final coat.

3. *On Old Interior Walls.* Old paperhangings, flaking material and distemper to be thoroughly removed. Repair cracks, etc., with plaster of Paris tinted with body colour Duresco, touch up and coat three times with Duresco of tint (the last coat to be stippled), same to be mixed and applied in accordance with the printed directions on the packages.

4. *On New Exterior Walls.* Coat the walls once with Duresco mixed with Silicate Petrifying Liquid, touch up and when dry coat twice (or three times) with Duresco of tint, same to be mixed and applied in accordance with the printed directions on the packages.

5. *On Old Exterior Walls.* (When only two coats in all are specified.) Thoroughly remove all loose and flaking materials by steel wire brushing and washing. Repair cracks, etc. Touch up porous patches with a stout mixture of body colour Duresco and Silicate Petrifying Liquid before and after first coat. Coat twice with Duresco of tint, same to be mixed and applied in accordance with the printed directions on the packages.

6. *On Old Exterior Walls.* (For porous surface on walls previously distempered or painted.) Remove badly scaling material. Bind surface with one coat of permanent zinc white paint, to be mixed according to the directions. Apply two coats of Duresco of tint, same to be mixed with Silicate Petrifying Liquid and applied in accordance with the printed directions on the packages.

7. *On Interior Walls over Lining Paper.* Prepare the walls, line with white lining paper, butt, but do not lap the joints. Coat the paper twice (or three times) with Duresco of tint, mixed with Silicate Petrifying Liquid (the last coat to be stippled), same to be mixed and applied in accordance with the printed directions on the packages.

8. *On Woodwork.* Duresco is eminently suitable for use on woodwork, either as a finishing coat or as an under coat for paint or enamel work, but owing to variation in surface and character a specification must be designed to meet the requirements of each individual case.

9. *On Asbestos Cement Fire-Proof Building Sheets.* When the

asbestos cement is damp and pliable well rub in Silicate Petrifying Liquid before and after fixing. Stop joints with Duresco mixed stout with plaster of Paris. When dry the surface may be finished in two stout coats of Duresco mixed with Silicate Petrifying Liquid; stipple the final coat.

SPECIFICATIONS ISSUED BY CITY AND BOROUGH ENGINEERS.

Engineers and architects, in drawing up specifications for the supply of painters' materials of various kinds for the use of public bodies, should be particularly exact, in order that competitors may be put on an equal plane.

The following extracts are taken from specifications issued in various towns. They are all official, and the author desires to thank the city and borough engineers and architects who have been so kind as to send him the documents from which the extracts are made. They will all repay a careful study, and will be of assistance in drawing up a complete specification regulating the supply of any of the materials named according to the particular circumstances.

The author has thought it desirable to make a few comments upon these specifications under their various heads.

The letters following the extracts refer to the particular town or borough from which the original specifications were received. Thus, all marked (A) come from the same town, and so on.

General Clauses.

"The goods or materials to be supplied under this contract are to be of the very best quality, and in every respect equal and answerable to the patterns and samples (where given), and such as the corporation, or its officers duly authorised, shall approve." (J)

Comment.—This is mutually contradictory. By all means let the supplies be equal to standard, in which case the contractor is responsible for the material only, but the corporation officers are responsible for the results. Such an arrangement makes no provision for a *more suitable* ingredient or preparation, and as the value of a paint or varnish material can only be guaged by the extent to which it is suitable to the purpose for which it is intended, it follows

that the *most suitable* material must be very best quality; no matter whether its intrinsic value be greater or less than the standard.

In their own interests, therefore, some phrase for incorporation in specifications should be agreed upon by public bodies which will leave a way open to the consideration of reasonable offers from manufacturers—offers which may prove of the highest value to the bodies in question. These in their turn should provide, collectively or individually, some machinery for establishing or refuting the contention of the tenderer.

One of the most serious complaints advanced by merchants and manufacturers who tender for the supply of dry pigments, paints and varnishes to public corporations and borough councils is that many of the goods supplied under contracts which include specifications worded in the loose manner given above do not and cannot conform to the specification. This is often due to ignorance on the part of the buyer as to the nature and qualities of the goods bought, but it is also often due to the ruthless and one may say scandalous cutting which takes place in the price. It is not fair to tenderers to specify a particular grade of goods and then to accept a grade which is lower and cheaper.

Tendering to sample is the fairest and most satisfactory plan, and every tenderer should be supplied with identical samples.

Colouring Pigments.

To specify correctly the *colouring pigments* that are to be used in the work which ordinarily comes within the province of the engineer and architect is somewhat difficult. It is useless to require that all such colours shall be fast, *i.e.*, shall not fade on exposure to sunlight, because certain pigments in ordinary use inevitably change colour somewhat, whatever their quality may be. For example, Dutch pink and Prussian blue do not possess the same degree of fastness, certain well-defined conditions affecting the intrinsic hue of each. In the case of certain pigments, such as siennas, umbers, etc., chemical analysis tells us little of the pigmentary value; the purity of tone or hue is the essential property.

There are many considerations which regulate the grade or

intrinsic value of a pigment, and many a so-called *pure* pigment may be worthless as a painter's material.

The qualities which generally constitute a high-class pigment are: (1) purity of tone—(*a*) as a self colour, (*b*) when reduced with a white pigment such as zinc oxide; (2) fineness of particles; (3) chemical and physical stability; (4) fastness to light; (5) absence of destructive action on other pigments.

A pigment, for instance, such as ultramarine blue or purple brown of high quality, reduced with good mineral barytes, may easily be of much greater value for painting and decorating purposes than either of the two pigments in the unmixed condition..

Among the fine colours, such as chrome, etc., it may be generally expected that the lower grades will contain a proportion of barytes or other reducing agent in an inverse ratio to the price charged, and it naturally follows that when required for staining purposes a correspondingly larger amount of the cheaper article will be required to produce the tint that will result from the use of the pure pigment.

It is undesirable in many cases to specify that pigments shall be free from barytes, as that mineral is a necessary constituent of some pigments, such as Brunswick green, vermilionette, etc. The highest grades of house painters' colours also may contain an appreciable proportion of barytes or its equivalent without detriment to their suitability and efficiency.

The colours put up in tubes are usually of superior quality, and it is a good plan to specify the product of some well-known firm, with the provision alluded to elsewhere as to the substitution of another make of equal quality in case it is required.

Coming to the pigments which contain oxide of iron, such as umbers, Indian and Venetian reds, purple browns, etc., is is usual to give the percentage of iron oxide contained, and it is also very desirable to mention whether the colour is to be artificial or natural. In the former case it should be free from acid. In some oxide of iron colours the percentage of ferric oxide is very large; in others, such as Venetian red, much smaller.

It must be realised, however, that richness of colour, staining power and fineness are features of paramount importance, since an

iron oxide pigment might answer all the requirements enumerated in the previous paragraph and yet be devoid of beauty and of so coarse a texture as to cause it to settle out in the paint pot in an incredibly short space of time.

Paints.

"All paints should be commercially pure. The composition of the paints shall be as follows: pigment (dry), 75 to 80 per cent.; oil (linseed), 17 to 20 per cent.; turpentine and liquid driers, 3 to 6 per cent." (A)

"All paints must be mixed for colours with pure, raw linseed oil, and refined linseed oil for whites; but in black slow-drying and oxide paints a portion of the oil may be boiled linseed." (B)

"All paints shall be commercially pure. The composition of the paints shall be as follows:—pigment (dry), 75 to 80 per cent.; oil linseed, 17 to 20 per cent.; turpentine and liquid driers, 3 to 6 per cent." (C)

"The whole of the painting materials shall be pure and unadulterated, of the best quality, and shall be composed of pure turps, boiled linseed oil, patent driers and mineral colours ground in oil; the white lead to be the best old English white lead in the original casks; the varnish to be the best hard-drying polishing copal from an approved manufacturer." (E)

Comments.—(A) to (C). The term "commercially pure" is an absurdity, as no definite meaning can be assigned to it. While a serviceable paint will often result from the percentages given, yet there are many cases when the ratio of pigment to liquid is much lower.

(B) Refined linseed oil, while possessing many valuable properties, is by no means an essential ingredient in white paints. Presumably it is specified with the object of securing the minimum of discolouration in the white paint, but raw linseed oil will in most cases be found to bleach out in drying, and the paint becomes quite as good a white as if the refined variety were employed. The insistence of pure raw linseed oil for colours precludes the possible advantageous incorporation of boiled linseed oil and also of varnish

which the latter half of the specification recognises, and it is open to the manufacturer to declare any paint slow drying.

(D) While seemingly comprehensive, is of little value. No clear indication is given as to whether this specification applies to stiff colour or ready mixed paint. In the latter connection the terms "pure and unadulterated and of the best quality" are, as already explained, meaningless. The white lead should be "genuine." There is no criterion as to what the word "best" implies. Boiled linseed oil could not be used, for instance, in a good white zinc oxide paint.

As no mention is made as to the nature of the oil in which the colours are to be ground, and no limitation is placed on the permissible addition of patent driers, opportunity is given to any plausible contractor to supply paint containing a heavy percentage of deleterious oil and also of unnecessary mineral matter. *Varnish*—Hard-drying polishing copal varnish would be quite unsuitable for exterior work.

The number of pigments and other solid substances that enter into the composition of paint is very great, and as each pigment varies in its physical properties, it follows that no general formula can be given to embrace all paint, the manufacture of which is a great industry and a science.

A general specification for paint in paste form (stiff paint) might read:—

"The stiff paint to consist solely of (umber, sienna, oxide of iron, etc.) pigments free from all added adulterant, and linseed oil either raw or boiled, or a mixture of both; the said stiff paint to be finely ground and so prepared that it can be prepared for use by means of the materials and method usually employed by painters."

In the case of Brunswick green paints, some limit should be set to the proportion of barytes or other white base contained in the pigment itself (say, 10 to 20 per cent.), as this could not be described as added adulterant.

A general specification for ready mixed paints might read:—

"The paint to be of the desired colour and to be composed of the most permanent pigments that can possibly be used to produce that colour, along with such thinners and driers as will enable the paint

to dry with a uniform glossy (flat, half-gloss, etc.) surface in (10—12—14) hours when applied on a suitably prepared surface under normal conditions. The paint must also effectively obscure the surface below, be finely ground and well mixed, and capable of standing for   years under conditions of fair wear and tear.

Red Lead.

"All red lead to be genuine pure English red lead, prepared solely from a suitable natural oxide. It shall not contain more than 3 per cent. of impurities, and be of good colour and free from grit." (A)

"To be genuine oxide of lead and to contain not more than 3 per cent. of impurities, to be of good colour, smooth and free from grit." (B)

"Pure oxide of lead, nor more than 3 per cent. impurity." (C)

"All red lead to be genuine pure English red lead prepared solely from a suitable natural oxide. It shall not contain more than 3 per cent. of impurities, and be of good colour and free from grit." (D)

"Red lead, dry, genuine (to contain not more than 2 per cent. impurities)." (E)

"To contain not more than 3 per cent. of impurities; to be of good colour, smooth, and free from grit." (F)

"Genuine red lead, dry (English make)." (G)

(A) and (D) are identical. The phrase "prepared solely from a suitable natural oxide" betrays gross ignorance. Red lead is a product of metallic lead, being an oxide of that metal, and produced at a high temperature by a furnace process.

Comments.—Among the above specifications (G) is undoubtedly the best, followed closely by (E) and (F). In the writer's opinion, however, (E) and (F) would have been of more value if all reference to impurities had been omitted, and the words "of the best commercial quality" introduced. It is within the bounds of possibility that an ingenious manufacturer might tone up the colours of his genuine but inferior produce with a small percentage of a bright aniline dye, and yet claim protection under the plea of

admissible impurity. This contention, however, would not be justifiable if "the best commercial quality" was demanded, since this phrase carries with it a demand for good colour, smoothness, freedom from grit, and all recognised essentials, as any expert would testify to the legal fraternity.

All the other specifications fail to recognise that there are numerous oxides of lead, of which one at least, *i.e.*, litharge, while also an important material in the paint and varnish industry, should in no wise be substituted for red lead. Any contractor, however, who chose to send litharge in place of red lead to (C) would be perfectly justified in so doing.

If "genuine red lead of the best commercial quality" be specified, it would be difficult, if not impossible, for any tenderer, however ingenious, to get behind the specification without running the risk of a legal action.

White Lead.

"The white lead shall be genuine; it shall be of English manufacture, made by the stack process, finely ground and of the highest quality. It shall be perfectly free from barytes and all other adulteration. It shall contain not less than 25 per cent. and not more than 33 per cent. hydrate of lead." (A)

"To be composed of pure basic carbonate of lead, containing not less than 25 per cent. or more than 30 per cent. of hydrated oxide." (B)

"White lead, pure carbonate of metallic lead, perfectly free from spent matters and well matured." (C)

"The white lead shall be genuine; it shall be of English manufacture, made by the stack process, finely ground and of the highest quality. It shall be perfectly free from barytes and all other adulteration. It shall contain not less than 25 per cent. and not more than 33 per cent. hydrate of lead." (D)

"Genuine white lead, best quality, not less than a year old (prepared from pure English lead)." (E)

"White lead in oil, genuine (basic carbonate of lead, containing

not less than 25 per cent. or more than 31 per cent. of hydrated oxide ground in refined linseed oil)." (F)

"White lead to contain not less than 27 per cent. or not more than 31 per cent. hydrated oxide." (G)

"Warranted genuine white lead, corroded by ordinary Dutch process and ground in pure refined linseed oil." (H)

"The white lead to be the best 'genuine' Old English white lead." (I)

Comments. In general, the specification governing the supply of white lead should contain the following points:—

1. Chemical composition and the limits of variation should be stated, for instance, "White lead shall be the commercial hydroxy-carbonate of lead containing not less than 11 per cent. or more than 13 per cent. of carbon-di-oxide."

2. A statement should be made as to whether the supply is limited to English manufacture or not.

3. It should be stated if the particular process of manufacture is essential, such as stack (Old Dutch) process, Chamber or Brimsdown.

4. It may provide for the absence of adulterants, such as barytes, although if the word "genuine" is prefixed, this is implied, and legal action will be risked if adulterants are present.

5. It should provide for efficiency in those properties which are independent of the composition, such as fineness of grinding and colour. These points are often overlooked.

6. It should provide for the chemical inertness of the pigment, and that it is properly washed and free from such materials as basic acetate of lead.

(A) Fairly sound. The specification being for *genuine* white lead, any qualification as to adulteration is redundant. As the white lead is required to be finely ground and of the highest quality, there is no reason for limiting the manufacture to the stack process since any other process either will give equal or better results, and should therefore be admissible or else will be inferior and would be excluded under the terms of the specification.

(C) The composition here given is not correct, and it does not correspond with that of white lead which is not "pure carbonate of

metallic lead," but hydroxy-carbonate. The expression "perfectly free from spent matters" is vague, and possibly refers to particles of tan, etc.

(E) The clause "not less than a year old," is not a guarantee of quality, and in any case is an impossible provision nowadays. The provision that it shall be good "pure English lead" is quite unnecessary, as is the provision that the pigment be made from "pure metallic lead," which is a chemical curiosity never met with outside a chemical laboratory. The restriction that the metallic lead should be mined in England is an interference with the business of the white lead manufacturer; it serves no practical purpose.

(F) and (G) The limitations of composition are rather stringent, and no provision is made for the several points above mentioned.

(H) The qualification "corroded by ordinary Dutch process" is good if it has been settled quite distinctly that lead made by that process is desired. The clause, while permitting the use of foreign white lead, however, excludes all modern processes by which a pigment is produced substantially identical with stack made white lead.

Nearly all white lead specifications lose sight of the fact that the material specified is not really white lead at all- that being a dry powder consisting solely of the well-known commercial hydrated carbonate of lead- but white lead ground without admixture with any other pigment in genuine refined linseed oil.

Bearing this point in mind, we might write a general specification for genuine ground white lead thus :—

"It shall consist wholly of the best commercial hydrated carbonate of lead, free from acetate of lead and all traces of impurity derived from the manufacture, finely ground to a stiff paste with the best commercial grade of genuine refined linseed oil."

Whether or not the material supplied under such a specification conforms to it or not becomes a simple question of fact which can easily be determined by referring the matter to an expert in case of dispute.

It should be borne in mind that basic sulphate of lead is not white lead, and cannot be described as such in Britain without the risk of a legal action being incurred.

Linseed Oil.

"The linseed oil must be well matured. At a temperature of 60° F. the specific gravity of the raw shall be from ·932 to ·937, and the boiled from ·940 to ·948." (A)

"Oils (boiled linseed). To be genuine steam-boiled pale linseed oil, free from sediment, to dry satisfactorily without the addition of other driers, and not to contain resin. Oil which has been prepared with resinate driers and other similar substitutes will not be accepted, and the specific gravity must be from ·943 to ·946." (B)

"Oils (raw linseed). To be pure linseed oil of the finest cisterned quality, free from footings and sediment, and suitable for painters' work. The specific gravity must be from ·930 to ·939." (B)

"Specific gravity.—·932 to ·925 at 60° F. Must stand the 'spawning' test." (C)

Linseed oil, raw (pure).

Linseed oil, boiled (pure). (D)

"The raw linseed oil to be best refined free from spurious oils, specific gravity at 60° F. to be between ·932—·935. The free acid calculated as oleic acid not to exceed 2 per cent. To be free from 'foots'."

"The boiled linseed oil to be the best refined, specific gravity at 60° F. to be not less than ·943. A thin layer on a glass plate must dry in eighteen hours when exposed to the air in a room at a temperature of 60° F. To be free from resin and foreign oils." (E)

Comments.—The object aimed at in specifications relating to linseed oil, whether raw or boiled, should be to ensure the obtaining of a commercial pure oil which is suitable for mixing with ground paste pigments to produce a serviceable mixed paint. Three qualities must be present in such oil: (1) the absence of added adulterants; (2) the absence of deleterious matter in the oil itself (albuminous matter, moisture, etc.); (3) the presence of satisfactory drying properties.

The following specification for raw linseed oil will secure these results:—

"The raw linseed oil shall be genuine and free from admixture with any other material whatsoever. It shall be perfectly bright and clear, and of the usual colour, and shall not become cloudy or deposit any sediment if kept at a temperature of 50° F. for a week. Its specific gravity shall be ·933 at 60° F. When heated gradually to its boiling point, it shall not spawn, that is, produce particles of flocculent matter. When mixed with 5 per cent. of its weight of ordinary terebine manufactured by a varnish maker of repute, it shall produce a film which will dry on glass in eighteen hours at 60° F."

A specification for boiled linseed oil may read:—

"The boiled linseed oil shall consist wholly of genuine linseed oil, and be free from admixture with other oils, rosin and resinates. The driers present in the oil shall consist solely of lead compounds derived solely from either litharge or red lead. The oil shall be clear and free from suspended matter and foots, and shall have a specific gravity of not less than ·942, and not more than ·945 at 60° F. A film on glass shall dry with a tough bright surface in eighteen hours at 60° F."

Resinate driers are used in many commercial boiled oils, and open the door to adulteration with rosin. If it is desired to admit resinate boiled oils, the foregoing specification can be readily modified.

Turpentine.

"The turpentine shall be refined genuine American, be free from adulteration, and have a specific gravity of ·867. It shall not begin to distil below a temperature of 150° C., but shall all be distilled before a temperature of 170° C. is reached." (A)

"Refined, genuine American, free from adulteration (optical rotation not less than + 1° to + 2°). The specific gravity at 60° F. to be between ·866 and ·868, and when distilled 97 per cent. should distil between 150° to 160° F., and leave not more than 2 per cent. of resinous residue." (B)

"The turpentine shall be refined genuine American, be free from adulteration, and have a specific gravity of ·867. It shall not begin

to distil below a temperature of 150° C., but shall all be distilled before a temperature of 170° C. is reached." (C)

"Turpentine, American (pure)." (D)

"The turpentine to be free from colouring matter with a specific gravity of ·87 and to be the best pure American spirit." (E)

"Turpentine, genuine American spirit." (F)

Comments.—The first point to be noted is that it is doubtful at the present time whether the term genuine American turpentine includes the variety of turpentine obtained by distilling portions of resinous woods, and now termed "wood turpentine." In order to be on the safe side, the specification should begin by stating that:—

"Only genuine American turpentine (gum turpentine) obtained by the distillation of the virgin resin will be admitted, and wood turpentine is excluded."

If the purchaser is willing to admit the wood turpentine, the above wording may be modified accordingly.

The specification should then go on to state:—

Colour.—The turpentine shall be perfectly clear, free from suspended material and water white.

Specific Gravity.—Shall not be less than ·862 or more than ·870 at 20° C.

Refractive Index.—Shall be between 1·468 and 1·476 at 20° C.

Boiling Point.—Shall be between 152° and 158° C.

Distillation Test.—When 200 c.c. of the turpentine are distilled, 95 per cent shall pass over below 170° C.

Evaporation Test.—Evaporate 10 c.c. on a large glass dish until there is no more loss in weight. The residue should not weigh more than 0·150 gram.

Driers.

"All patent driers shall contain not less than 10 per cent. of lead oxide." (A)

"Driers to contain 13 per cent. basic carbonate of lead, 5 per cent. white sugar of lead (acetate), and 2 per cent. borate or acetate of manganese." (B)

"All patent driers shall contain not less than 10 per cent." (C)

"Patent driers (sample to be submitted)." (D)

"Driers to contain not less than 20 per cent. of lead or manganese preparations." (E)

"The driers to be litharge or massicot, but patent driers will be allowed to be used if containing not less than 50 per cent. of genuine white lead." (F)

Comments.—Among the above specifications (D) is the only rational one. The lead oxides are coloured substances (red lead, for instance), and a white paint would be an impossibility if a driers such as (A) and (C) or (F) were employed.

If, again, driers should contain any appreciable proportion of basic lead carbonate (genuine white lead) (B) or (F), the pigmentary opacity thereby resulting would interfere with the tone of many paints into which they were introduced, particularly the fine colours.

(E) A driers containing 20 per cent. of manganese preparation would be much too concentrated for ordinary purposes, and would require most careful handling.

The function of patent driers is to assist paints to dry in a reasonable period, and it should be clearly defined what weight should be required to a fixed quantity of raw linseed oil, thus: "The patent driers to be of good material, and containing no oil other than linseed oil, and of such strength that the addition of 7 lbs. to a paint consisting of 1 cwt. of genuine white lead in oil and 2 gallons raw linseed oil will cause it to dry in eight to ten hours under normal conditions without discolouration."

It may be noted, however, that white lead being itself a drier, the drying effect of a given patent drier on white lead paint may not be the same as that obtained when the same weight is added to a bad drying paint, such as Indian red. It is often preferable, therefore, to specify that the strength of the drier shall be such that 7 lbs. of it will cause a paint consisting of nothing but Indian red and raw linseed oil to dry within twelve hours.

Gold Size.

Coachmaker's gold size. (A)
Best Japan gold size. (B)

Gilders' gold size. (C)

The term "gold size" implied originally a true gum varnish rich in gum and poor in oil. The difference between (A), (B) and (C) has grown out of the different methods of work adopted by coach painters, japanners, and gilders respectively.

Coachmakers' gold size should consist of nothing but a suitable hard resin (free from rosin), linseed oil and American turpentine, with the necessary driers, and should be capable of being mixed with pigments to produce a hard stopping which dries quickly and can be polished down, and also of being mixed with undercoating body varnish to hasten the drying.

Japan gold size may be specified to conform to the same requirements.

Gilders' gold size should be specified to dry with a "tack" ready for gilding in so many hours.

Varnishes.

"The varnish is to be the 'finest pale durable copal' for internal work, 'pale copal carriage' for external work, and 'engine copal' for hot pipes, radiators, tanks, guards, etc. All to be obtained from selected manufacturers." (A)

"All varnishes to be made with pure American turpentine and to be free from rosin." (B)

"1. Best teak varnish.
2. Best hard drying oak varnish.
3. Best patent knotting varnish.
4. Best black japan.
5. Best black lacquer.
6. Church seat varnish." (C)

"Pale oak varnish Hard varnish Mastic varnish Hard oak varnish Copal oak varnish Carriage varnish	All varnishes to be made from the best gums and oils, to flow easily, dry lustrous, and with a firm coat, in eighteen to twenty-four hours." (D)

All varnishes shall be made from carefully selected materials. Only the best copal gums shall be used dissolved in the best well-matured Baltic linseed oil, mixed with turpentine, as hereinafter

specified. They shall be at least six months old before delivery, flow easily, and dry lustrous with a firm coat in not less than twenty-four and not more than thirty-six hours." (E)

"Varnish, copal. Copal varnish to be made from best pure gums, oils, and pure American turpentine, to flow easily, dry lustrous, and in twelve hours, so that dust will not adhere, and hard in twenty-four hours, and to be free from resin or copal substitute." (F)

Comments.– All varnishes shall be made from carefully selected materials. Only the best hard gum resin shall be used, and the oil shall be the best well-matured Baltic linseed, and the turpentine as hereinafter specified. They shall be at least six months old before delivery, flow easily, and dry lustrous with a firm coat in not less than twenty-four and not more than thirty-six hours.

It is a most difficult matter to specify the composition of a varnish, and it is probably much better to specify precisely what kind of results are aimed at, the time allowed for drying, and the price that should be paid, thus :—

"The varnish to conform to the description hard church oak, to be perfectly bright and well matured, and to dry hard without tack on inside seats within twenty-four hours. To present a lustrous surface under fair conditions of wear for two years, and to cost not less than 10*s.* 6*d.* per gallon."

Terebine.

"Finest. One part of terebine, when mixed with 16 parts of linseed oil and spread in a thin layer on a glass plate and kept at a temperature of 60° F. must dry in eight hours. To contain not less than 10 per cent. metallic oxides." (A)

"The terebine shall be genuine American and be free from adulteration. When 1 part of terebine is mixed with 16 parts of linseed oil and spread in a thin layer on a glass plate and kept at a temperature of 60° F., it must dry in eight hours." (B)

"Finest. One part of terebine, when mixed with 16 parts of raw linseed oil and spread in a thin layer on a glass plate and kept at a temperature of 60° F., must dry in eight hours. To contain not less than 10 per cent. metallic oxides." (C)

"The terebine shall be genuine American and be free from

adulteration. When 1 part of terebine is mixed with 16 parts of linseed oil and is spread in a thin layer on a glass plate and kept at a temperature of 60° F., it must dry in eight hours." (D)

Comments.—(B) and (D) are ridiculous, and are evidently the result of a confusion with American turpentine. Terebine is, of course, an article made in England by all varnish manufacturers. It would be an exceedingly difficult task to define what constituted an adulteration thereof.

The best mode of specifying is to provide that it shall be made from the best materials, shall not injure any pigments or paints with which it may be mixed, and that 5 per cent. added to genuine raw linseed oil will cause a film on glass to dry in a given number of hours at 60° F.

Putty.

"Is to be made from whiting and linseed oil and well worked into a stiff paste." (A)

"To be composed of pure calcium carbonate and pure raw linseed oil." (B)

"Putty, in drums (carbonate of lime and pure linseed oil)." (C)

"Putty (made with pure linseed oil)." (D)

Comments.—This should be described as genuine linseed oil putty consisting of finely powdered whiting and genuine linseed oil.

(B) This form of specification is incorrect, pure calcium carbonate being a product of the laboratory, and not a commercial product at all.

Whiting.

"The whiting to be dry and of the best quality, free from alkalinity, well ground and free from grit." (A)

Gold Leaf.

"Each book shall contain twenty-five leaves, measuring 3¼ inches square, and be of quality known as "best deep English gold leaf," weighing from 4 to 4½ grains, and be 22 carat." (B)

"Transfer gold leaf (best quality British)." (H)

Proposed Standard Definitions of Terms Used in Paint Specifications.

As approved by the American Society for Testing Materials.

Standard.—A term designating a quality or qualities specified.

Equal to.—The use of this term should be avoided if possible.

Pure.—Standard, without adulteration.

Commercial Pure.—Is not defined, and should not be used in specifications, as it involves the absence of "Standard."

Adulteration.—The partial substitution of one substance for another.

Adulterant.—A substance partially substituted for another.

Bulk.—The bulk of a pigment shall be considered as the total volume of the pigment and the voids, and varies inversely as the specific gravity of that volume.

Voids.—The space between the particles of a pigment, even though occupied by air or by a vehicle, whether liquid or dried.

Opacity.—The obstruction to the direct transmission of visible light afforded by any substance, comparison being made with sections of equal thickness. The opacity in the case of pigments should be considered as referable to their opacity in a vehicle under standard conditions.

Covering Power.—The use of this expression should be avoided as being confusing.

Hiding Power.—The power of a paint or paint material, as used, to obscure optically a surface painted with it.

Spreading Power.—The relative capacity of a paint or paint material, as used, of being brushed out to a continuous uniform paint film, expressed in terms of the area to which a unit volume, as used, is applied.

Fineness.—A term used to denote the extent of subdivision and expressive of the number of particles of pigment in a unit volume exclusive of voids.

Crystalline.—Having a definite structure referable to one of the systems of crystallography.

Amorphous.—The opposite to crystalline.

Paint.—A mixture of pigment with vehicle, intended to be spread in thin coats for decoration or protection, or both.

Pigment.—The fine solid particles used in the preparation of paint, and substantially insoluble in the vehicle.

Vehicle.—The liquid portion of a paint.

Volatile Thinner.—All that liquid portion of a paint, except water, which is volatile in a current of steam at atmospheric pressure.

Non-Volatile Vehicle.—The liquid portion of a paint, excepting water, which is not a volatile thinner by the above definition.

Tinting Strength. The relative power of colouring a given quantity of paint or pigment selected as standard for comparison.

Colour. A generic term including the colours of the spectrum, white and black, and all tints, shades and hues which may be produced by their admixture.

Tint.—A colour produced by the admixture of a commercial colouring material, excepting white, with a white pigment or paint, the white predominating.

Hue.—The predominating spectral colour in a colour mixture.

Tone.—The colour which principally modifies a hue, or a white, or a black.

Drying.—The solidification of a liquid film, independent of change in temperature.

Drier.—A material containing metallic compounds added to paints for the purpose of accelerating drying.

Specific Gravity.—The relative of a unit volume of substance compared with the weight of the unit volume of water at defined temperatures.

Gallon.—This refers to the American gallon which is smaller than the English Imperial gallon. The latter contains 277¼ cubic inches, and is therefore approximately one-fifth larger than the American. The English gallon is equal to 10 lbs. avoidupois of distilled water weighed in the air at 62° Fahrenheit, the barometer being at 30 inches.

Density.—This is a purely scientific term. Its use should be avoided in specifications.

Water.—Dissolved water, or water not definitely or chemically combined.

Dry.—Containing no uncombined water.

NOTE.—In view of the importance of specifications regulating the execution of painting work and the supply of painters' materials being accurate and comprehensive, and at the same time reasonable from a commercial point of view, the author is prepared to make suggestions on the subject when requested. In difficult cases or where the work involved would require much time, he will be pleased to put readers in communication with paint technologists who will for a suitable fee, to be arranged draw up any specifications required.

CHAPTER X

PAINTING BY MECHANICAL MEANS

ALTHOUGH a certain class of painting must always be done by hand, as for instance, the wood, iron or cement which forms part of a permanent structure, other and quicker methods such as spraying may be employed successfully when the surface is sufficiently large and accessible. When the articles to be treated are relatively small they may be painted by dipping them bodily in a tank which contains a paint of a suitable composition. In some cases the two processes may be combined and the under coats be put on by dipping and the finishing coats of paint or varnish be sprayed on; or the finish can be done by hand if desired.

In the United States of America the dipping and spraying processes are employed to a very considerable extent, and in this country they are increasing rapidly in use among engineers, the manufacturers of agricultural implements, waggons and carts, baby carriages, furniture, sheet metal, corrugated iron, enamel ware, etc.

Spraying may be used with great advantage in painting celluloid and paper for paint makers' pattern cards, while dipping by hand is now usually employed for cans intended to contain paint and varnish. Much better results are obtained in both cases than by using a brush, and not only is the appearance improved but the saving of time is very considerable.

Spraying paint in house painting can be done with advantage on flat surfaces, such as a wall to be covered with water or oil paint, and it is particularly useful for delicate stencil work. The dipping process is at present used in house painting to a very limited extent. Iron casements and other comparatively small parts are sometimes so treated, although it seems probable that

wooden sashes and even doors and other details might be treated in this manner before being fixed, at least for the priming coat.

The methods of combining dipping and spraying do not appear to be much used at the present time, and it will be convenient to consider them quite separately. It should be added, however, that there is ample room for improvement in this direction, and in many cases work which is now finished by hand can be done much quicker and more economically by spraying on the last coat, whether it be paint or varnish. Of course, the operator in spraying must have had some amount of practice in order to become expert. When once the knack is acquired there is but little difficulty in obtaining a uniform coat, or one, at least, as uniform as would be produced if a brush were used. The process of spraying paint consists in forcing the distemper, paint, enamel, varnish or lacquer on to a surface by means of compressed air supplied by a tube or hose, the paint, etc., being supplied through a second hose and being broken up into exceedingly small particles by the compressed air at the point of emerging from the nozzle.

Painting by dipping consists in bodily dipping the article to be treated into a tank containing a suitable paint, immediately lifting it out, allowing it to drain for a few minutes and then suspending it until dry, when it sometimes receives a second coat and sometimes a third.

In a paper read by the author before the Paint and Varnish Society, the advantages and disadvantages claimed for both systems were thus summarised :—The first advantage of both methods is a great saving of labour. In spraying, from two to three square yards can be covered on a plain surface in one minute, or say, at a very low estimate, a hundred square yards an hour. It would take a man with a brush, working at the rate of five square yards an hour, which would be very fast, twenty hours to do the same work.

In paint dipping the saving is much greater, and this can be shown by quoting figures obtained on a visit of inspection to the dipping plant at the Royal Woolwich Arsenal Carriage Department. Before this painting plant was put in two hundred painters were constantly employed ; now forty-one are able to fully cope with the

same amount of work or even more. In comparing the two systems it should be remembered that when a surface is painted by the aid of a brush at least one-half of the time involved in the operation is lost by the workman in dipping his brush, drawing it against the side of the can to remove superfluous paint and in returning to the surface. A second advantage of spraying is a considerable saving of paint which may be taken at 33 per cent., and as it is generally admitted that two thin coats of paint are much more durable than one thick one and as the actual spraying takes little time the durability of this method is increased. The makers of the various paint-spraying machines usually claim that the thickness of several coats of paint may be obtained when desired by one operation, in other words by continuing the spraying until any desired thickness of paint film is obtained. The author cannot too strongly deprecate this practice. Thick coats of paint to be durable must be made up of several thin coats, and far better results will be obtained by first thinly spraying, allowing at least several hours—or in cases of a slow drying paint, etc., twenty-four hours—and then spraying on a second coat and so on to the finish.

A further advantage is that the paint both with dipping and spraying penetrates those portions of the work which cannot be reached by means of a brush. For example, in a waggon that is dipped the paint finds its way into the joints which are always more or less open, and the fact should not be lost sight of that it is these parts which under ordinary circumstances are most likely to first perish when they are not protected by paint. When paint or whitewash is sprayed on a rough brick wall all the inequalities of the surface are reached by the spray, and this could not be done with a brush.

We may now consider some of the disadvantages urged against the two systems. The objections usually urged are that the film of the paint put on by spraying is not likely to be so uniform in thickness as that put on by a skilful painter with a brush. As against this it may be said that an ordinary coat of paint applied by a painter, however skilled, is far less uniform in thickness than is usually supposed. If paint is brushed on very carefully to a transparent substance, such as a sheet of celluloid, it will be found

that, however uniform its appearance may be, when held up to the light considerable variation is apparent. It is also claimed that the paint put on by dipping is not forced into the pores of the wood as it would be when applied with a brush, and the same is true to a smaller extent when spraying is resorted to. There is probably something in this objection so far as it relates to dipping, but when the paint is sprayed a considerable force can readily be obtained which would exceed that exerted by a painter who uses a brush.

SPRAYING APPARATUS.

The appliances used for spraying may be divided broadly into two classes. First, those intended for spraying limewhite, whitewash, disinfectants, etc., which consist of a single hose through which the lime, etc., is forced by means of a pump, usually operated by hand, and is discharged through a nozzle in the form of a spray on to the surface. This type is largely employed for limewhiting rough brick walls of railway arches, factories, etc., and in such cases does the work far better and quicker than would be possible if a brush were used.

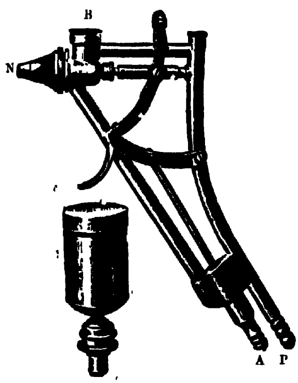

FIG. 33.—Handpiece used in Paint Spraying.

The second class of spraying machines consists of two separate hose, one supplying the paint, which may be as thick as any paint which can be put on by hand, and the other hose supplying air under pressure which is operated by hand or power pump and is discharged from the nozzle in close proximity to the paint, which it breaks up in the form of spray.

The illustrations show the most largely used machines of the

first class and give sufficient idea of their construction. The patented instrument known as "The Aerograph" may be taken as a type of the second class, and it is largely used in many industries and can be employed in its various forms, ranging from the execution of the most delicate work, such as a portrait, to spraying whitewash or limewhite on a very large uneven surface. The diagram (Figure 33) gives an idea of the handpiece by which the spraying is effected. In operation two flexible tubes are connected with A and P, A supplying the compressed air, and P the colour, paint, varnish or distemper which is also under pressure. The finger lever F controls both the air valve and the colour valve in the Nozzle N, so that little or much colour may be allowed to pass out into the current of escaping air. This colour is usually supplied from a large paint pot, or, when small quantities are required, from a cup C, which is attachable at B and, when so attached, cuts off the supply through the tube P. The cup is useful when small quantities of colour are wanted with frequent changes. The outfit for ordinary painting consists of a spray paint together with a large paint pot and pump. There are several different patterns of the Aerograph all more or less working on the same plan as that illustrated. The capacity of this varies from three to five square yards per minute. A fairly thick paint may be used if desired, as the apparatus is controlled by means of a needle in the nozzle which keeps it free and permits the air to

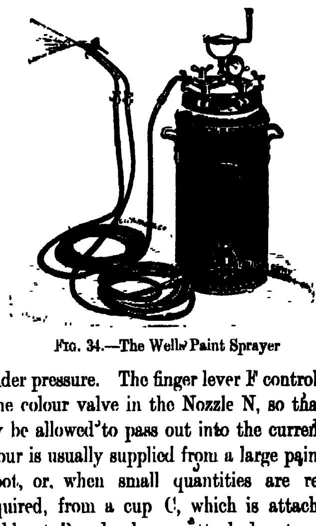

FIG. 34.—The Wells Paint Sprayer

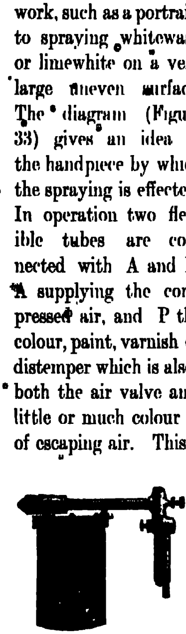

FIG. 35.—The Lederer Paint Sprayer.

operate upon the colour and divide it up into small particles. In showing the many different uses to which this apparatus may be successfully put it may be mentioned that most of the large wallpaper manufacturers have several in constant use, while it is also employed in spraying enamel on to tubes to form bedsteads and for other uses. A difficulty is sometimes experienced in applying aluminium paint by means of a brush. It can, however, be most successfully applied by means of the spraying machine.

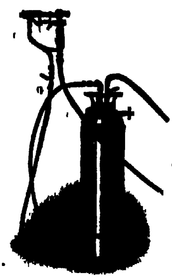

FIG. 36.—The Lederer, larger Type.

Another type of machine of class 2 is the "Wells," which is specially recommended for large surfaces, and is used by many of the principal railways and industrial firms. The rate of surface covered is from twenty to thirty square feet of surface in one minute with an ordinary paint. In this case the paint cylinder is contained

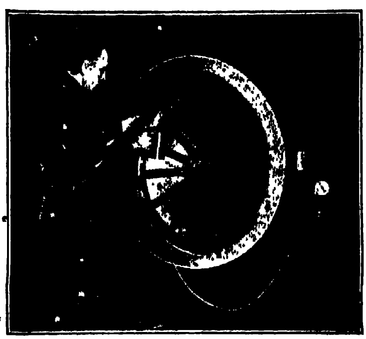

FIG. 37.—Painting a Cart Wheel by Spraying.

inside the air cylinder or tank, as shown in Figure 34. The paint pot is removable so that the colour can be changed as may be

desired. The air, which is supplied from a compressor is either driven by hand or power at a pressure of from 15 to 30 lbs. per square inch according to the peculiar conditions of the work. The paint is forced up under this pressure from the tank, where it is broken into a fine spray by compressed air supplied from the second tube. There are various sizes of this machine, and the consistency of the liquid to be applied may vary from that of tar to ordinary whitewash.

Another type of spraying machine is the "Lederer," made at Buffalo, N.Y., and is illustrated in Figs. 35, 36 and 37. This is made in two styles, one having a cup, and the other a tank when large quantities of articles are to be treated. In the first of these the air passes out of the nozzle when a button is pressed under a pressure varying from 10 to 50 lbs. according to the weight of the material. This induces the paint contained in the cup to rise and pass out of the vertical tube and here it is broken up into a soft spray. Paint sprayers may be used for a large variety of purposes. Figure 37 shows how a cart wheel may be painted by the Lederer machine.

Spraying Colour Cards.

Colour specimens suitable for mounting on cards for the purpose of paint manufacturers may be readily produced by the spraying process and a considerable saving effected. The effect of glossy enamels on such colour cards is often obtained by painting on the back of transparent celluloid. The usual plan followed is to brush on the paint considerably thicker than would be the case if it were to be applied to, say, a door. The difficulty is to obtain a paint which is not too flat and not too glossy. If the former, the paint film will be so brittle that it will crack under the guillotine when the celluloid is cut into pieces suitable for mounting. If too oily the danger is that it will separate or peel off from the celluloid. By spraying on the paint a more uniform surface can be obtained than when a brush is used, and various improvements can be made without a great deal of difficulty. Assume, for instance, that it was desired to show two or more colours on the same piece of celluloid, as, for example, a suggestion for striping on a carriage. The

stripes would, of course, be in one colour and the body to represent the carriage in another. In such a case the stripe could be sprayed on first by using a stencil perforated with the exact width of line or lines required and these being dry the main colour could be sprayed in over the whole surface, provided that care was taken that the colour used for the stripe was not transparent. Again, if each sample is of fair size it might be wished to place in the middle of each piece the name or number, and this could be sprayed on through a stencil in the manner indicated, the finishing being proceeded with as before.

It will sometimes be found that the best results are obtained by using a glazing colour in producing a given finish, such, for instance, as a brilliant red can be obtained by using a less brilliant red as a ground and glazing with a lake. In preparing celluloid for this purpose the lake would, of course, be put on first and the Indian red, or whatever the colour might be, last; the ordinary process being in fact reversed.

In painting paper for specimen colours cards where the finished effect is to be oily paint, flat enamel or distemper, the desire is always the same, viz., to give a perfectly uniform surface, and this can be done by means of the spray far better and quicker than can possibly be done with a brush. The labour of stippling a distemper is saved and brush marks are wholly avoided.

Spraying Through Stencils.

It not infrequently happens that it is necessary to put on a special device, name or trade mark to some part or other of an article after it has been painted, either by dipping, spraying or other means. By the exercise of a little ingenuity this may be done very quickly by means of a spraying machine, which may in this case be quite small. The stencil should be provided with a clip or gauge to save time in obtaining the exact position of the device, and frequently it will be found advantageous to form a frame or holder in which a number of articles can be arranged side by side. The stencil will then be made with a repetition of the

devices all exactly in the correct position, and the actual work of spraying will take but a few minutes.

Lines, corners, scrolls and ornaments of various kinds can also be put on by spraying through stencils, and it is sometimes found desirable to spray on the ground and afterwards to touch up or finish the work by hand. Thus the ground of an heraldic lion which might form part of a trade mark could be sprayed on through a stencil and the necessary lines to complete be put in afterwards by an artist.

Engineering says: "The field for spraying in engineering work would appear to be very large, and it is matter for surprise that the system is not more widely used, unless it be that the process has disadvantages which do not at first sight appear. For the treatment of bridges, roofs, and other structural ironwork, the system is apparently very well suited, while for the painting of ships' hulls, which frequently has to be carried out in very limited time it should be ideal. A spraying plant of any magnitude naturally requires some form of motive power for working the air-pump, but this would usually impose no difficulty for the type of work we have in mind. It is clear that the greater the amount of clear flat surface in the work to be painted the greater will be the advantage of spraying, and in some cases it would naturally not be suitable."

PAINTING BY DIPPING.

The subject of painting by dipping may conveniently be divided up under the following heads: (1) the dipping tank, (2) the paint, (3) the lowering and hoisting apparatus, (4) the arrangement for hanging the articles after being dipped. A little consideration will make it clear that each of these details is of considerable importance and that, if one is not properly arranged, the plant as a whole may be a failure.

Taking these in order we have first to consider the construction of the tank. This may be of almost any dimensions regulated by the size of the articles to be dipped. For example, at the Woolwich Arsenal, they dip a whole waggon at one time, as is shown

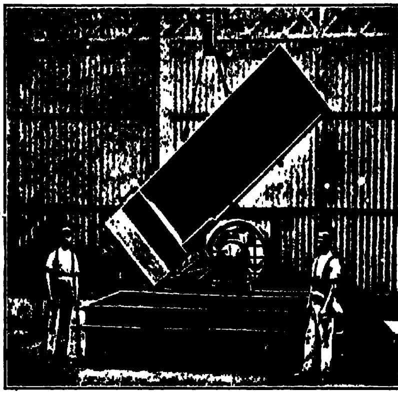

FIG. 38.—Dipping Waggons in Paint at Woolwich Arsenal.

in Figure 38, and hang them in rows, as shown on the left of Figure 39. In other cases small articles, such as machine parts, are dipped by being placed in wire-bottomed trays or in wire baskets. There

FIG. 39—Hanging Waggons after they have been Dipped.

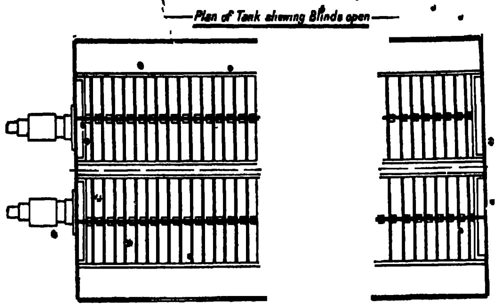

FIG. 40.—The Wilkinson, Heywood and Clark Paint Dipping Tank—Plan.

are, doubtless, tanks of varying construction in successful use. The author is only practically acquainted with three types.

The first and second may be said to be designed on a somewhat

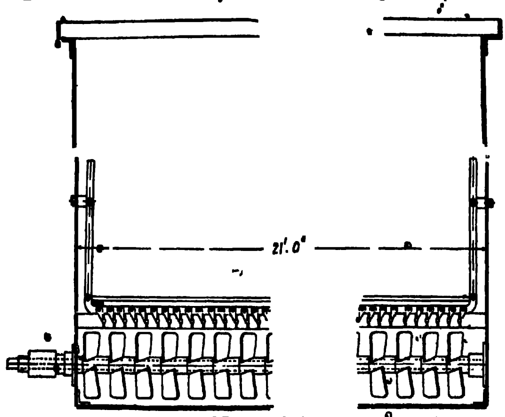

FIG. 41.—Vertical Section of Fig. 40 showing Paddles.

similar principle, viz., to include an appliance for agitating the paint after the pigment has settled, as, for example, during the night-time or week end. The third type is merely a plain box or tank

tapering toward the bottom and provided with no agitating appliance, the paint being merely stirred up from the bottom with poles as may be required. The illustrations (Figures 40, 41 and

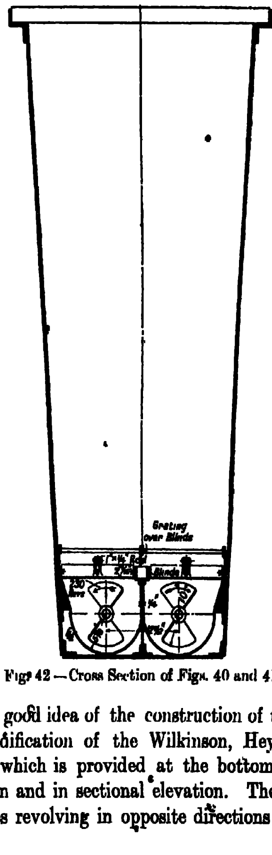

Fig. 42 — Cross Section of Figs. 40 and 41.

42) give a very good idea of the construction of type No. 1. This is a slight modification of the Wilkinson, Heywood and Clark patented type, which is provided at the bottom with paddles, as shown in section and in sectional elevation. There are two series of these paddles revolving in opposite directions and above them

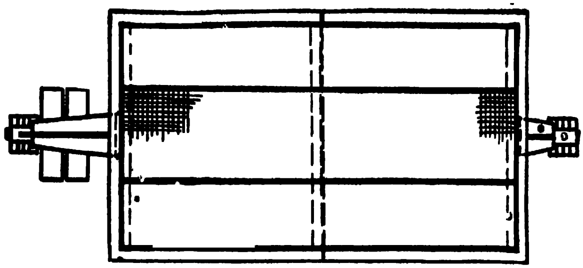

FIG. 43.—The Lewis Berger and Sons Dipping Tank—Plan

is an appliance, which may be likened to a horizontal venetian blind, which is left open when the tank is in use, and is closed when at rest.

The second type is shown in Figures 43, 44 and 45, and is that of Messrs. Lewis Berger and Sons, Limited, and, as will be seen by the

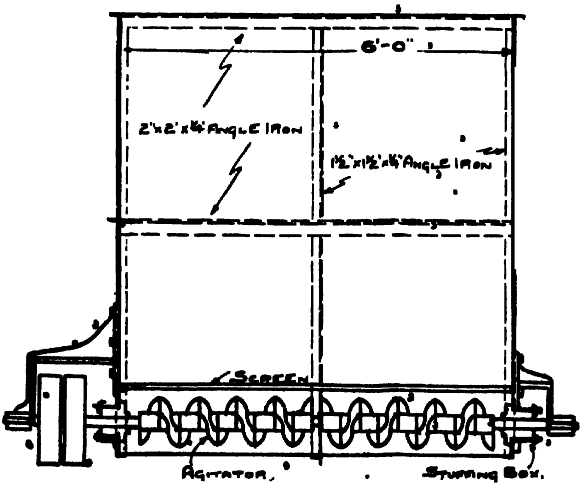

FIG. 44 —Section of Fig. 43, showing Worm Agitator at Bottom

section, tapers considerably so as to involve the use only of a single agitator at the bottom. The construction of this is more of the nature of a worm than of paddles. An additional agitator may be used when circumstances require it. The body of the tank is one-eighth inch iron or steel and the weight about 495 lbs. There is no shutter above the agitator, but a wire screen which is found to be sufficient

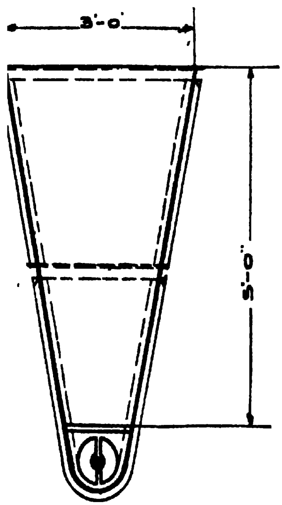

FIG. 45.—Cross Section of Figs. 43 and 44.

for the purpose. A screen is also sometimes used over the shutter-like arrangement for the first type. When the articles to be painted are of considerable size there may be two series of agitators, and the extent to which they should be used and their exact form will obviously depend upon the particular kind of paint used. It is not deemed necessary to refer in detail to the construction of the tanks as the drawings supplied make it sufficiently clear, and the manufac-

turers would doubtless be willing to supply a full set of drawings to those about to put in a plant.

The Paint to be used for Dipping.

Obviously success in painting by dipping depends largely upon the kind of paint used. As a rule it will be necessary that it should dry quickly, say in six hours, and with this object in view a large amount of gold size is usually employed. The pigments must be finely ground in order to prevent undue settling and ensure a reasonable durability, and the mixture must be such that there will be but few, if any, "drips," "tears," or "fat edges," after the article is dipped. If any such occur they must be brushed off immediately after the article is dipped.

At this writing there appears to be two distinct camps among the few who have studied the subject, one side strongly urging the necessity of paddles or some sort of an agitating apparatus, to keep the pigmentary portion of the paint in constant suspension, and the other, who are equally assertive in their claims, urging that a properly designed paint should consist of pigments and thinners substantially of the same specific gravity, so that no considerable settlement can take place and hence no agitators are necessary but only occasional stirring up by means of poles, etc.

Without deciding between these opposed opinions of practical men, it can only be said that at the present time agitators are in actual use in, perhaps, nine out of ten dipping plants, although there appears to be a strong tendency towards the adoption of special paints which do away with the necessity of their use.

We may here quote from "White Paints," a book published at Chicago, Ill., and written by Mr. W. G. Scott, who has had a large and varied experience in this class of work. The author of the work mentioned gives the following as a typical white dipping paint:—

300	lbs.	Sublimed white lead
100	„	Zinc oxide
60	„	Gilder's bolted whiting
40	„	Asbestine pulp
93	„	Raw linseed oil.

making altogether about 20 gallons. This paint is recommended for dipping agricultural implements, woodware, etc., and when there is an agitator it may be reduced with 14½ gallons of benzine, 4 gallons raw linseed oil and ¾ gallon of liquid drier. As a rule, however, white spirit is employed instead of benzine, the remarkable increase in the use of this product being due to the fact that it has been proved to answer its purpose and to take the place of turpentine even for ordinary painted work.

The price of white spirit is, of course, very much lower than that of American turpentine, say 9*d.* to 1*s.* 2*d.* per gallon, as against, say 2*s.* 4*d.* a gallon for turpentine. Some varieties contain a proportion of turps in order to give something of the characteristic smell, but this is merely pandering to prejudice, as the smell of white spirit is less pungent than that of turpentine. The flash point of most grades of white spirit is from 90° to 95° F. close Abel test, and it is water white. The specific gravity is about ·810 at 60° F.; that of pure American turpentine is ·867.

The following points concerning dipping paints are worthy of careful note. They are based upon the opinion of Mr. Scott. A certain amount of oil must be present in dipping paints to act as a binder and it is advisable to add a small quantity of varnish to hold the paint together. Non-absorbent surfaces like metal, hard wood, etc., require less oil than the absorbent soft woods. In the former because there is little or no penetration of the liquid portion of the paint; but with pine, whitewood, poplar, etc., nearly all of the liquid is absorbed in the first coat. Secondly, benzine or white spirit when used alone as a thinner will not be sufficient to act as a binder when the thinner evaporates, hence the addition of a little oil or varnish or both. A small amount of inert material, such as china clay or barytes, is usually understood to be improvement in the way of durability, although an excess, of course, destroys to some extent the body. "Asbestine" is recommended for dipping paints because of the quality it possesses to hold a pigment in suspension. Asbestine, it may be mentioned, is specially ground for paintmakers' use, and it can be obtained from most manufacturers of asbestos. The specific gravity is about 2·612, and the composition is, approximately, silica, 70 per cent.; mag-

nesia, 23 per cent., the remainder usually consisting of alumina combined with water and a little iron oxide. White lead and zinc oxide are, according to Scott, the two ideal white pigments considered from a dipping standpoint, zinc oxide generally predominating.

The following recipes are taken from the work, "White Paints," already named, but have been changed to meet existing conditions and accord with English weights and measures:—

Primers for Metal. 4 to 5 lbs. of paste paint thinned with ½ gallon of white spirit and 1 pint of mixing varnish.

Primers for Hard Wood. 4 to 5 lbs. of paste paint thinned with 3 quarts white spirit or turpentine, 1 gill raw oil and ½ gill mixing varnish.

Primers for Soft Wood. 4 to 7 lbs. paste paint thinned with 1½ to 2 quarts white spirit, 1 to 2 quarts raw oil, 1 gill to ½ gill varnish. In some cases with very soft, porous woods, it may be necessary to add more raw oil and some japan or liquid drier, but too much drier must not be added as it will shorten the "flow."

Second Coat Dipping Paints.—5 to 10 lbs. of paste paint thinned entirely with white spirit or with 2 quarts of solvent and variably proportioned oil and varnish according to the surface desired.

Varnish is advocated in all of these mixtures as it helps to hold the solids and liquids together and prevent separation; it also induces toughness.

It is essential that a varnish be used which will mix perfectly with oil and benzine at a temperature of 60° F.

White Dip for Metal.

100	lbs.	White paste paint.
11	gallons	White spirit.
1½	quarts	Pale mixing varnish.
1½	pints.	White liquid drier.

White Dip for Hard Wood.

100	lbs.	White paste paint.
10	gallons.	White spirit.
1½	"	Raw linseed oil.

1½ pints	Mixing varnish.
1½ ,,	White liquid drier.

White Dip for Soft Wood.

100 lbs.	White paste paint.
9½ gallons	White spirit.
4¼ ,,	Raw linseed oil.
2¼ ,,	White liquid drier.

The pale mixing varnish and the white liquid drier must not liver with lead or zinc, otherwise the paint in the tank will thicken continually. The above formula produces one of the best paints known and it is certainly not a cheap paint.

Vermilion or Pink Primer (semi-paste).

70 lbs.	Zinc oxide.
30 ,,	White lead (carbonate).
46 ,,	Whiting.
10 ,,	Silica.
25 ,,	Venetian red; grind in.
5 gallons	Raw linseed oil.
1¼ quarts	Grinding Japan.

Dip for Iron (Heavy).

100 lbs.	Pink primer paste.
6 gallons	White spirit.
1½ gallons.	Turpentine.
1¼ quarts	Mixing varnish.

Dip for Hard Wood (Medium).

100 lbs.	Pink primer paste.
8 gallons	Benzine.
1½ ,,	Turpentine.
1½ pints	Liquid drier.

Dip for Soft Wood (Thin).

100 lbs.	Pink primer paste.
9¾ gallons	Benzine.
6 „	Boiled linseed oil.
1¼ quarts	Kerosene oil.

The kerosene oil is added to promote "flow" and to render the material more waterproof. The small quantity of kerosene is absorbed by the wood and does not materially retard the drying. By adding more paste or more thinner, the consistency may be regulated to suit variable conditions.

Quick-Drying Primer (semi-paste). Pink Primer for Iron.

100 lbs.	Zinc oxide.
87½ „	Bolted whiting.
12½ „	J.F.L.S. ochre.
25 „	Venetian red.
	Grind in :
7½ gallons	B. and T. Grinding Japan.
1¼ „	Raw linseed oil.
1½ quarts	Mixing varnish (slow drying).
1½ „	White spirit.

To the above may be added the remarks of a gentleman who is attached to a firm making a speciality of dipping paints. He says: "The general method with large American houses is to use one primer for everything, and considerable experience shows that a grey primer is the most suitable colour for this purpose. A grey, being a neutral tint, does not interfere with the finishing coat, and it can be covered with red, green, blue, yellow or any colour desired for a finishing coat. By the use of a neutral tone of this kind the apparatus and operations are simplified. The paints for dipping purposes are ground to extreme fineness in special mills, and are made on light bases, so as to avoid settling as far as possible. In shallow tanks an ordinary paddle is sufficient to agitate the paint, but in dipping tanks, where large sections of machinery or implements are dipped, it is advisable to have [illegible]

agitator. The handling of small sections of implements may present a little difficulty at first, but these are usually put together into an iron basket, made somewhat like a wickerwork basket of rounded steel, so as to allow the paint to drain away; and these baskets may contain anything from fifty to one hundred small sections, which can all be dipped together effectively. The materials used, being ground so finely, as stated above, and containing all the necessary drier, only turpentine substitute need be added to thin in the tank for the first batch. Subsequent batches, however, require a small percentage of boiled oil to be added at the same time as the thinners, as, owing to evaporation of the thinners, the binder of the paint is liable to be cut out, particularly after standing in the tank for any length of time. I recommend about one gallon of boiled oil to ten gallons of thinners, which serves to keep the whole mass bound. These paints are made plainly on a non-lead base and give great satisfaction."

The following useful information is kindly given by Mr. F. A. Lane, of Philadelphia, a gentleman who has erected a very large number of tanks for dipping purposes: "Dipping material is unsatisfactory where the thinners are light in specific gravity as compared with the pigment. It is impossible to do clean and economical tank work without the proper agitators, and this cannot be secured by using a plain tank and stirring with wooden paddles. To get the desired finish the usual method is first to prime the articles, and paint for this purpose should be composed principally of white lead and zinc oxide with a reasonable amount, about 25 per cent., of calcium carbonate or silicate of magnesia ground in linseed oil and sold in paste form. The colour of the first or priming coat may vary from white to deep lead colour, depending upon the coats that are to follow. If the finish is to be white, then the priming should be white; if the work is to be finished in yellow or chrome, the prime should be tinted a deep buff colour or light yellow. If the work is to be finished in vermilion, the best practice is to have the priming a deep pink or rose colour. If the work is to be finished in green, the prime should be tinted green or lead colour; and if finished in black, a deep lead colour is most satisfactory priming. If to be finished in maroon or tuscan red, a

terra-cotta colour makes a satisfactory first coat. In all these paints white lead and zinc oxide should be used to a very large extent, and the paste thus formed by being ground in linseed oil is reduced with a thinner composed principally of benzine, turpentine or white spirit.

"When the paste is reduced to a proper working consistency and the article is immersed in the tank where the usual agitation is going on the paint flows readily and the film sets quickly, so that there are no runs or fat edges. If an excess of oil is used, or a large amount of turpentine used, there will be after runs which cause a very unsightly appearance. From the very nature of such a mixer constant agitation is necessary.

"This priming dries with a slight egg-shell finish. A second coat of the desired shade is then dipped on. If it is white, the composition would be principally white lead and zinc oxide; if yellow, the composition should be white lead and chromate of lead: if vermilion, it may be para vermilion, or it may be what might be vermilionette.

"The article is finally dipped in varnish. This varnish must be especially made for dipping purposes. It should be long in oil, have a medium heavy body, and be thinned in the tank, usually by adding one part varnish reducer and two parts varnish, and the article immersed in this. This gives the desired gloss and protects the striping and decorating. Varnish reducer is made similar to paint reducer except it does not contain as much drying salt, and of course the colour is paler."

The Hoisting Apparatus.

It is clearly of great importance that the actual lowering of the article to be dipped and raised should be done very expeditiously

When the plant is small the lowering and hoisting is often done by hand, but where it is extensive either pneumatic or electrical hoists are employed, the latter being usually preferred. In Figure 46 is given an illustration of an electrical power travel hoist of two-ton size. It is a special hoist of compact design, running on the underflange of a mono-rail joist of I section, one

motor being provided for the lifting motion and a second motor for travelling it along the rail. If the weight is small, say not exceeding a few hundredweights, the second motor can be dispensed with and a similar hoist employed which would be pushed along by means of a handle provided for the purpose. This hoist can be made to shift articles directly on to the single rail. The cost of electricity is very small It can, of course, be varied in construction according to the particular article to be dipped. This particular apparatus is made by the Witton Kramer Co., of Witton, Birming-

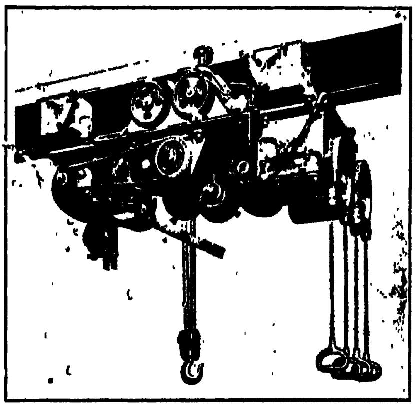

FIG. 46.—Electric Hoist used in connection with Paint Dipping.

ham. Various hoists may be employed varying according to the exact work to be done.

Mr. Lane, already quoted, says: "In reference to hoists, an electrical hoist will answer very nicely, but nearly all implement and vehicle manufacturers have their plants equipped with compressed air, and compressed-air hoists are cheaper than electrical hoists. Compressed-air hoists of small cylinder type are easily operated and require no attention, cannot get out of repair and are very positive in their motion, while an electrical hoist is very sensitive and easily damaged, is bound to get out of repair and

require the services of an electrician, and the danger of fire must be considered. It can readily be understood that in a room where dipping is done, and where the hoist of necessity would have to be placed, the atmosphere is pregnated with volatile gas, and, if a hoist is behaving badly, sparks and fire will result. For that reason we recommend compressed-air hoists in dipping rooms."

Arrangements for Hanging Articles after being Dipped.

In this important detail of a dipping plant opinion varies very largely as to what is the best system to be adopted. In some of the

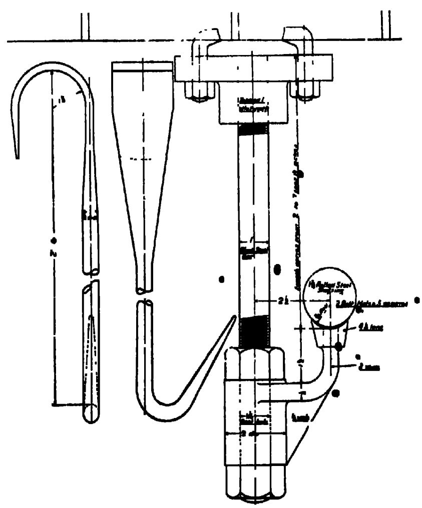

Fig. 47.—Hooks for Hanging Articles after Dipping.

places visited, preference would appear to be given to two rails with rollers on each. On the whole, however, the author believes that the mono-rail is the most satisfactory, particularly so as in that case the wheels may be dispensed with and a hook, similar to that shown in Figure 47, be employed instead. The con-

struction is sufficiently clear from the illustration, but it should be explained that in connection with this simple appliance vaseline is freely applied on the rail. The particular appliance illustrated is designed by Edwards and Shaw, of Birmingham. The runway commences at a height of 12 to 16 feet above the floor and inclines at an angle of about 1 in 60, and this incline may be increased to bring the articles nearer the floor for taking off. The runway itself consists of $1\frac{3}{4}$ inch bright steel bars, which are kept greased with vaseline, as stated. Supports to the runway are fixed about 5 feet apart. The hooks vary in length from 2 feet 6 inches to 6 feet, so that the articles hung on them will not be too high. It is necessary for these hooks to be flattened out on the portion which runs on the rail in order to readily pass over the joints between the different sections of the rail. Curves, where required, are better at about 18 inches radius, although it is quite easy to get round 9 inches radius even with unwieldy articles. Switches to divert the goods into any direction consist of bends 12 inches radius, the one end turned down to $1\frac{1}{4}$ inch diameter for a length of about 9 inches to enter into the bored-out end of the steel rail. The other end, which extends 9 inches beyond the end of the radius, is planed off on its underside so that it tapers down to a blunt point. The side track is $1\frac{3}{4}$ inch above the main track, so that the switch, when down, lies on the top of the main track, the tapered end being just flush with the track. When out of use this switch is turned vertically upwards. There is not the slightest necessity to use rollers on the hooks. One push of the hook when loaded will often carry it 10 or 15 feet, and in some cases these hooks have been fixed to run several hundred feet distance, and the goods pass along them quite easily as fast as a man can walk.

In concluding this chapter, brief mention may be made of some of the details of the various plants the author inspected during the summer of 1912.

Messrs. Marshall, Sons & Co., of Gainsborough, agricultural implement manufacturers. The greater part of the work done at these works, where 4,000 men are constantly employed, consists of treating the red wood forming part of the threshing machines, and on an average 4,500 pieces pass through the dipping plant every

month. The paint tank is 21 feet long, 8 feet deep, and 3 feet 2 inches in width. The tank is provided with two propellers, as shown in Figures 40, 41 and 42. The propellers are actuated by electric motors, but the hoist is raised and lowered by pneumatic appliances with a supplementary electrical appliance. Only the priming coat is done by dipping. The article having been dipped, it is allowed to drip for a few minutes and is then taken away on overhead rails, a double run being provided. The present plant was put in during January, 1903, and has worked with complete satisfaction ever since. Once every year is sufficiently frequent to empty the tank in order to clean it out. This tank is provided with four iron doors which protect the contents from fire during the night, and ducts are provided in the side for ventilation. White spirit is used exclusively in place of turpentine. Some parts of the threshing machines consist of thousands of holes bored in the wood, and it would take many hours to paint these parts by hand, but by dipping it is done in a few seconds. Before the actual dipping takes place shellac knotting is applied to all the knots. The usual process is to knot by hand, prime by dipping, and then finish with two coats, one on red (flat), and a final coat of varnish put on by hand, although I am of opinion that this might be done by spraying. All painters and dippers are put on piece-work, and this is found to greatly facilitate operations.

Harrison, McGregor & Co., Leigh, Lancashire. The tank used at this place is provided with a worm at the bottom to agitate the mixture when required, and a grille or grating at the top of the worm protects it and prevents any small pieces of wood, nails, etc., from clogging. The lifting apparatus is worked by compressed air, and each part, as dipped, drains over a slanting board or platform communicating with the tank. Parts of the machinery made of iron are dipped directly after they come from the moulding shop to prevent them rusting. Grey paint is usually employed, but no lead whatever is used in these works. The thinners are white spirit mixed with gold size in generous proportions. Small articles are either placed in wire baskets for dipping or are suspended on hooks attached to a cross-bar.

Henry Hope & Sons, Birmingham. This firm are ironfounders

on a large scale, and use a dipping plant for castings, such as casements, ordinary galvanised iron sheets, etc. The tank is a narrow one, and when the sheet is raised from the dipping tank it is suspended by one corner and drips over a slanting board. Grey is the colour mostly used, and in three or four hours the coat of paint is dry. As a matter of precaution, however, twenty-four hours are usually allowed to elapse between the coats. The tank is not provided with an agitator, the paint used being specially prepared so as not to settle to any extent. It is, however, necessary to stir it each morning before commencing operations. The articles are suspended on hooks over a single rail treated with vaseline in the manner already described.

ROYAL ARSENAL, WOOLWICH.

In 1904 the author visited the Royal Ordnance Factories at the Woolwich Arsenal, and by the courtesy of the Chief Superintendent was allowed to inspect the plant and take photographs. These appeared in the press in November, 1904, and are reproduced in Figures 38 and 39, as the construction to-day is essentially the same as then. On a recent visit it was found that various improvements had been made during the interval, the chief of which were that petroleum "spirit B" is now used instead of benzine, and this does away with the necessity of the exhaust fan shown in Figure 38, which has now been boarded up. The venetain blind arrangement has been also done away with, it being found that a grating answers the purpose. In the hoist, which is worked by electricity, the authorities realised the danger in the case of fire of a man being located in a cab near the roof, and the whole of the operations are now done from the ground. Many different sections are now successfully dipped, sometimes a whole waggon at a time, while sometimes it is found more convenient to dismantle a vehicle and dip the wheels, four or five at the time, separately from the body. After dipping the article is suspended over the tank for a few minutes, and it is then transferred by a very ingenious apparatus from the hoisting apparatus to the rails, and after half an hour a man goes over the work and removes any runs or tears which may appear.

This, however, is a very small matter. For a further protection in case of fire each tank is fitted with an iron door or cover, and this may be shut down in position by merely pulling a lever situated at some little distance from the tank itself. The cover is surrounded by two-inch felt, which cuts off access to the interior. It is interesting to observe that white lead is still largely employed for the paint in these works. For the minor work small tanks are employed and the articles are dipped into these by hand. Iron work, such as bolt-heads, are dipped into a mixture composed of 15 parts gold size, 10 of boiled linseed oil, and 10 of petroleum, which effectually prevents them rusting. A very clever little idea is used in order to protect those parts which it is not desired to paint. This is done by smearing over them vaseline, which is removed with the paint after the main part is dry. As before stated, the number of men employed in this department is very much less than before the dipping plant was put in. Some portion of the work is done by hand, such as stencilling, although it is probable that by having a large stencil containing, say, forty-eight or so of the small stencils now in use, a spraying machine might be used economically.

Dipping Shells.

The description of this plant must, for obvious reasons, be somewhat lacking in detail. The shells are cylindrical in form with curved ends coming to a point, and two colours are mostly employed, one black, the paint in this case being bituminous base, and the other a somewhat rich yellow. The shells that are about to be dipped are placed each in gun-metal rings suspended in series of a dozen or so, depending upon the size. These are brought over to the tank, which is worked by hydraulic machinery, and the shells are left stationary while the tank containing the paint rises vertically to exactly the right height for covering the shells with paint. On pulling a lever this tank descends and, after being left for a short time to drip, a steel rail by which they are supported is moved out at an angle so as to come in line with the suspending rails which extend through the building. Here they are moved to any position required on a series of two rollers.

It is to be noted that no lead whatever should be used in the paint. Zinc oxide is used freely together with other pigments that are free from metal. The following is the composition of the principal paint used for producing the yellow colour referred to:—

	First Coat.	Second Coat.
Pure zinc oxide, dry, free from lead	9¾ lbs.	—
Boiled linseed oil, free from lead	1¼ pints	1¼ pints
Terebine, free from lead	1¼ ,,	2½ ,,
Spirits of turpentine	1½ ,,	1½ ,,
Oxford ochre	—	8½ lbs.

The author ventures to summarise his opinions on this subject as follows:—

1. Both paint spraying and paint dipping are capable of being employed in many more industries than they are at the present time.

2. A good priming and second coat of paint having been applied by dipping, the finishing coat, such as a good varnish, might be applied by a spray and would effect a great saving.

3. A wide difference of opinion exists as to the composition of dipping paints.

4. In spraying aluminium, lacquers, liquid bronzes, etc., on a very rough surface, the spraying machine will produce far better results than can be obtained by the use of a brush.

INDEX

BRADBURY, AGNEW, & CO. LD., PRINTERS, LONDON AND TONBRIDGE